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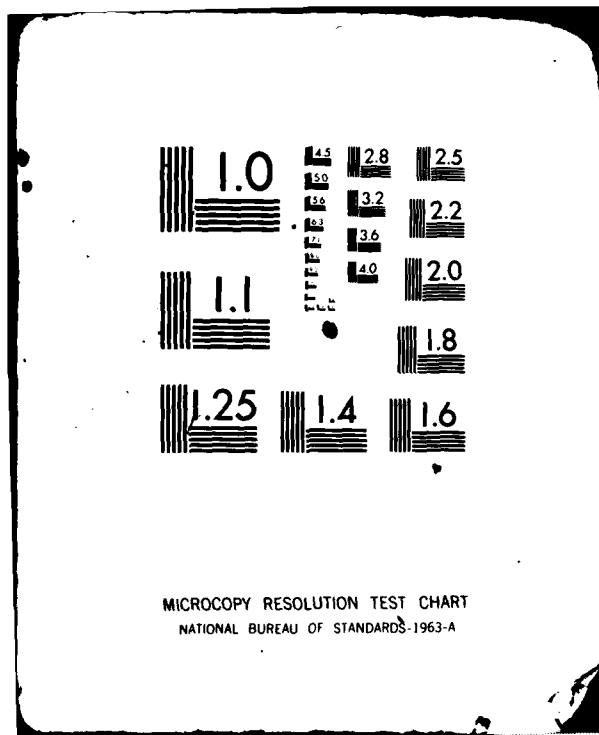4.0   2.0

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SEMREC3A

Volume I - User's Guide

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PREFACE

This document is intended to provide users of the
SEMREC3A version of the Soviet postattack economic
recovery model with the information required to
design, run and to some extent interpret model
simulations. For further details on applications
of the model and their interpretation, the reader
is referred to a second SRI International technical
note describing a baseline model simulation
together with two variants. The SMREC3A model,
like its predecessors was developed by SRI
International for the Defense Nuclear Agency under
contract DNA001-79-C-0102. Lt. Col. David Thomas
was the technical monitor and provided much
valuable assistance. This revised user's guide
supercedes all previous versions.

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I INTRODUCTION

A. Overview of the Model

SEMREC3A is a simulation model designed to provide a total-system picture of the functioning of a potential Soviet postattack economy. It is a set of equations which describe relationships, behavioral, technological or institutional, in nature, among economic variables. In many cases, the specification of these relationships and the estimation of their parameters are based on historical data. These relationships were explored in the development of SOVMOD, the peacetime econometric model of the USSR. In other cases, peacetime relationships have been replaced by a structure deemed more appropriate for a recovery environment and which incorporates the judgement of the analyst on values for key parameters. The introduction of initial conditions for recovery, i.e., exogenously given changes in capital stocks and population, is also provided for.

The SEMREC3A model has been coded for use with the TROLL software system. TROLL (for time-shared reactive on-line laboratory) is a set of computer programs designed for research in economics and other social sciences. TROLL has capabilities useful for building and simulating econometric models. It is maintained by the MIT Information Processing Service and can be accessed from remote terminals on a time-shared basis. The entire TROLL software can also be installed on a prospective user's own computer system if it has appropriate hardware characteristics.[1]

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[1] Information on gaining remote access to the TROLL System on a time-shared basis can be obtained from User Accounts, MIT I.P.S., Room 39-213, 60 Vassar St., Cambridge, Mass. 02139 (617) 253-4119; Information on purchasing the TROLL package can be obtained from Prof. Edwin Kuh, Department of Economics, Massachusetts Institute of Technology, Cambridge, Mass. 02139

Files containing the model equations, values for constants in the equations, and required data have been created and stored on the system. Using the appropriate commands in the TROLL language, data can be edited and assembled and key parameters can be set for a TROLL simulation of the SEMREC3A model. A further command starts the simulation: data are compiled, the equations are analyzed, and a computer code is generated to provide a solution to the set of simultaneous equations for each period specified. A further command causes the solution values for specific variables to be displayed.

B.   Purpose and Organization of the Guide

This users' guide for SEMREC is intended to supersede the initial users' guides produced at the end of the preceding phases of SEMREC research. The revised and expanded guide is intended not only to provide the user with information gained from verification and validation of SEMREC and the new SEMREC3A models, but also is intended to fill a broader purpose than the original guide. This broader purpose is to provide information on the modelling project and model application useful to policy-oriented considerations, and research design efforts which might incorporate model application.

Once the decision is made to explore the application of the model as part of the accomplishment of a research group, the users' guide provides the additional information required for structuring the model applications, and finally using the software system to generate model simulations. This users' guide has been expanded and revised as model research and application proceeded in order to accomodate modifications and improvements in model structure and software.

The remainder of the introductory chapter describes the major factors in the conversion of the peacetime econometric model (SOVMOD) to an econometric model appropriate for the analysis of the recovery environment. This section presents the essential outline of the modelling effort which has resulted in the current SEMREC model and the choices made in designing model capabilities.

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The second chapter presents a more complete description of model capabilities (and limitation), the role of the analyst in structuring model application, and the technical issues which relate to the interpretation of model output. This chapter, proceeding from a discussion of the type of insights to be derived from model application, is designed to guide the consideration of the appropriateness and utility of SEMREC in the accomplishment of a research task.

The details of SEMREC and SOVMOD structure are provided in Chapter III. This information is useful for an understanding of the models' assumptions about economic processes and interpretation of model applications, and is critical for the analyst who will structure and execute simulations. The structure of the model is detailed separately by model component and levers for analyst intervention are identified and elaborated.

Chapter 4 represents the terminal users' guide which is equivalent to an expanded version of the superseded initial users' guide. The use of the software system to structure, execute, and present output of model simulations is explained in detail. The use of individual operational commands appropriate to each model application step is presented. The final section of this chapter deals with common errors encountered in using the software and suggested corrective measures.

Documentation of the SEMREC3A model is provided in the Appendices. Each model constitutes a set of symbol declarations, equations, and a coefficient file.

It is suggested, although the users' guide is intended to be comprehensive and self contained, that users obtain TROLL manuals from the MIT Information Processing Service. These manuals will provide the user with additional tools for running, editing, and debugging the models.

It is important to note at the outset that while significant progress has been made in supplying a useful tool for analysis of potential Soviet postattack recovery, many opportunities remain for improvement of the model's capabilities. Useful insights about the economic dimension of recovery, which is, after all, a political-military and economic phenomenon, can at this point be derived from analysis via the SEMREC model.

C. Conversion of SOVMOD to SEMREC

1. General Descriptions

The final version of the Phase III SRI-WEFA Econometric Model was dubbed SOVMOD3C. It is a large model with about 280 equations. A subsequent model, SOVMOD3D, added an energy component with detailed modelling of fuel and energy consumption in the economy. Both of these models are best suited to short-term forecasting and scenario analysis without major departures from historical trends. SOVMOD4 adds to this model (SOVMOD3D) a disequilibrium adjustment mechanism. The result is more than twice the number of equations in SOVMOD3C and a model better suited to long-term forecasting and scenario analysis. The adjustment mechanism insures that solutions are limited to those feasible given a particular series of technology matrices, through the balancing of production and uses of output.

SEMREC1, the result of earlier phases of the research reported on here, represents a modification and adaption of SOVMOD3C. The important changes are detailed in this report. Most significantly, the projection of adjustments around historical trends is replaced, in many cases, by a set of decision rules appropriate to a recovering Soviet economy. It was discovered in the earlier phases of SEMREC research, that the mechanism which would provide improved long-term forecasting and scenario analysis capabilities for SOVMOD was critical to the SEMREC effort as well, since significant deviations from historical patterns must be carefully considered from the point of view of technological feasibility (linkages between sectoral and branch production) and impact of leadership objectives

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(linkages between production and final uses of output). Therefore SEMREC3A incorporates the disequilibrium adjustment mechanism and the energy component with the basic SEMREC framework.

2.   Characteristics of Enhanced Command

In adapting the SOVMOD peacetime model of the Soviet economy to reflect the relationships to be expected in the postattack environment, it was necessary to replace a number of equations with postulated relationships characterizing enhanced command--intervention by the center in allocation decisions. These modifications were primarily made in the mechanisms for allocation of labor and investment and the determination of consumption and foreign trade. Detailed discussion of the specifications of model blocks is presented in Chapter III.

In SOVMOD, allocation of labor among sectors of the economy and branches of industry is modelled and depends primarily on past patterns of allocation and on growth rates of investment categories. In SEMREC, labor is allocated by labor demand functions. These functions calculate the labor input required to produce the output for a sector or branch determined by the balancing and adjustment mechanism, given material inputs and capital stock. These individual labor demands are then scaled by a factor to insure that total labor allocated equals total labor available.

Investment allocation in SOVMOD is accomplished via several alternate methods. In the first alternative, investment is allocated among sectors and branches by exogenously determined shares, while total nonagricultural investment depends on gross profits, defense expenditures, and timing within the five-year plan cycle. In the other alternative, investment is determined by gross profits, defense expenditures, lagged growth rates of investment, and financing of centralized investment in the state budget.

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For SEMREC, the first alternative for investment allocation was chosen. That is, investment shares are set exogenously, diverging from historical patterns to reflect changes in central priorities. Initial targets for total investment are determined via a set of functions which appropriately modify peacetime trends guided by analyst levers. These targets enter into the balancing system and are adjusted to insure balance between sources and uses of investment goods.

Consumption in SOVMOD also is represented by alternative sets of equations. In one alternative, total consumption is a residual end-use category and shares of each form of consumption (food, non-durables, durables, and services) are modelled on past patterns, relative prices etc. In the two other alternatives, consumption functions either determine total consumption and shares are modelled as above, or they determine each individual component of consumption directly.

In SEMREC3 consumption targets are set as an analyst determined fraction of preattack per capita consumption multiplied by the population. There is provision for targets to grow over time on a per capita basis. These targets for consumption categories are then adjusted to ensure balance of inputs and end-uses.

The treatment of foreign trade also differs from SOVMOD to SEMREC. While it was considered important to treat the impact of possible external economic flows on the domestic economy in postattack recovery, it was deemed inappropriate to model foreign trade activity as is done in SOVMOD. In the peacetime model exports are determined separately according to commodity group and destination (developed West, LDC's, etc.) and depend on production levels, population growth, hard currency requirements, world trade activity, etc. Imports are similarly disaggregated and are a function of exports, lagged exports, consumption, etc. It is not reasonable to assume that in the postattack period these sorts of relationships would continue to hold. External economic relations would be closely managed by the leadership. Therefore, in SEMREC3, initial foreign trade flows are determined by target functions guided by analyst levers, which then enter the balancing mechanism (see Chapter III, Section K).

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3. Features of the Dynamic Adjustment Mechanism

In SOVMOD3D (a recent version of the peacetime model) industrial branch outputs are solely determined by a set of production functions relating output to primary factor inputs. Because production levels grow at a moderate rate from historically achieved levels (i.e., there is no major divergence from historical patterns) there is no need for explicit balancing of outputs and uses of industrial production. In SEMREC3, however, the initial conditions for a simulation may well result in production levels (determined by traditional production functions) for individual sectors inconsistent with a balance of supply and demand for output of each branch. Therefore a mechanism had to be devised which would check these balances and adjust output levels and end uses to assure balance in regard to production, interindustry use and final demand.

Adding the balancing/adjustment mechanisms may affect simulation values for some branches of industrial production, i.e., adjust output from the level given by the three-factor (capital, labor, and materials) production function. It is necessary, as well, to insure that the adjustment process does not result in unrealistically wide fluctuation between simulations as a result of small changes in exogenous variables (initial conditions, etc.) and that changes in production levels would follow a pattern consistent with leadership priorities across branches. Several alternative mechanisms, including a linear programming approach, were considered for the model. Because of the size and complexity of the task and the need to consider alternative approaches, the balancing/ adjustment component was deferred to the second and third phases of SEMREC research and is currently complete.

The alternative incorporated into SEMREC is a disequilibrium adjustment mechanism. In response to the imposition of consistency constraints (supply constraints), variables (outputs and end-uses) are adjusted to minimize a quadratic "cost function" which provides for smooth adjustments and reflects industrial branch priorities. A series of balances for branches of industry subtracts interindustry uses

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(calculated on the basis of input-output coefficients) and final uses from imports and gross output, as estimated in the production functions. Disequilibria then result in adjustments to estimated output values and end-uses to ensure consistency. It may be expected that this imposition of supply constraints will result in slower rates of recovery than indicated by simulations of the first-phase model.

4. Levers for Analyst Intervention

The SEMREC model, in describing the postattack economic environment, is based, in many aspects, on assumptions about leadership policies. These policy guidelines, for instance, relate to such questions as the length of the work week, maximum per capita levels of consumption, final deliveries to defense end-uses, etc. In the peacetime model, these variables are implicit in the parameters of the equations, are exogenously set based on policy pronouncements, or involve the use of dummy variables to reflect changes in policy during specific periods.

In SEMREC, however, assumptions about the postattack economic environment are incorporated in simulations via specific levers that can be set by the analyst. Primary among these levers are the priorities assigned to branches and sectors in the balancing of material inputs. These priority numbers are assigned on the basis of the importance of the output of the branch or end-use in achieving the hypothesized sets of leadership objectives. Thus, if the expansion of the stock of military durables is a key leadership objective in recovery, the priority numbers assigned to the machinebuilding and metalworking branch may be twice that assigned to the construction materials branch (it is the relative size and not the absolute magnitude of the number that is important in SEMREC). These priorities minimize adjustments to relatively highly weighted targets for outputs and end-uses.

In the determination of consumption, the analyst sets target per capita levels of consumption in four categories. If, for example, it was assumed that the effectiveness of political control in the postattack period was insufficient to secure necessary labor inputs at low levels of consumption, the analyst would adjust the minimum and maximum upward to provide increased labor incentives. The length of the work week (labor inputs are measured in man-hours) and the participation rate (ratio of labor force to able-bodied population) can also be adjusted by the analyst to represent changes in labor discipline.

These and other analyst levers, detailed in the section below on model structure, were incorporated into SEMREC both to replace peacetime mechanisms of SOVMOD inappropriate to recovery and to provide the user with the ability to examine the total system impact of varying assumptions about the postattack economic environment. In conducting model experiments, variations in key analyst levers have proved as important as moderate changes in initial conditions.

II USES AND LIMITATIONS OF SEMREC

A. Nature of Insights to be Derived from Model Application

The SEMREC model is designed to provide a total-system picture of potential Soviet postattack recovery. The recovery paths produced by simulations will differ widely, depending on assumptions made about the recovery environment. Our knowledge about the actual environment that might pertain to the recovery period is necessarily limited to a hypothesized range of controlling assumptions derived from peacetime experience, historical recovery periods (i.e., post World War II), and expert opinion of economists in regard to potential variation in these parameters. Beyond these initial guesses, for example, about the maximum share of investment in industry that might be directed to the machine-building sector, model simulations, giving total system responses to changes in these assumptions, provide inputs for setting feasible bounds on their variation. This same combination of expert opinion and simulation experiment is required to establish the range of initial conditions which the model can be expected to handle and still give believable results. The primary question, then, which SEMREC is designed to answer is, how much difference in the speed and profile of recovery is made by a change in the recovery objective, controlling assumptions, or initial conditions.

The detailed nature of the formulation of a simulation are discussed in the following section. Initial conditions relate to the reduction in capital stock and labor force resulting from the attack and pertaining at the start of the recovery phase, following a survival and reconstitution period (12 to 24 months). Recovery objectives and controlling assumptions are reflected in the model specification and, in many cases, by explicitly designated levers for analyst intervention. The specification of allocation mechanisms reflecting recovery environments to replace peacetime relationships was one of the major design tasks in creating SEMREC from the SOVMOD framework.

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The output of a model simulation consists of annual values over the simulation period (now a maximum of ten years) for the endogenous variables and definitions. These include aggregates, such as GNP, industrial output, consumption, etc., as well as outputs of economic sectors and industrial branches (there are six sectors of the economy, one of which is industry, which is further disaggregated into twelve branches). The TROLL software package permits results of alternative simulations to be displayed in a number of formats for comparative purposes. Thus the divergence of variants from a baseline simulation can be readily examined for impact on total system performance and key subcomponents of interest.

It seems useful to provide here some illustrative questions that might be asked by the analyst, to be answered via simulations of SEMREC with alternative sets of assumptions or initial conditions. These are by no means exhaustive:

- o   What effect on the rate of recovery of industrial production would be produced by a significant increase in the share of investment allocated to industry?

- o   Assuming identical patterns of damage, but a 15% increase in the general level of damage to the industrial capital stock, after five years of recovery what is the difference in the level of output of the machinebuilding and metal working sector (critical for both military and investment goods)?

- o   Relative to no external economic flows, what would a level of imports of 75% of pre-war CMEA, 50% LDC, 15% Developed West mean in terms of output of heavy industrial sectors? Light industry? Consumption levels?

- o   Does a reduction in damage to ferrous metallurgy and a concomitant increase in damage to petroleum products retard recovery?

- o   Does an extension of the work week matched by an increase in target per capita consumption result in a more rapid recovery?

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B. Structuring Model Applications

1. Initial Conditions

While the initial conditions for the recovery process really encompass a broad range of environmental descriptors, precise quantification of two sets of initial conditions are required in running a simulation of the SEMREC model. The first set specifies population losses, the second represents reduction in the capital stock. Initial conditions are introduced into the model via the use of archived data, which is explained in the terminal users' section of this guide. For guidance in setting such conditions, see SEMREC3A: Baseline Soviet Recovery Case CEPR TN-8156-2.

Able-bodied population is used in SEMREC to determine total available labor force (it is multiplied by an exogenously given participation rate--the 1975 value has been the usual assumption). The able-bodied population over the ten-year recovery period is hypothesized by the analyst and thus the population initial conditions are set. Model scenarios have been run with population reduction of 16, 24, and 31 percent. These three levels were intended to represent alternate assumptions about the effectiveness of Soviet civil defense in population protection, rather than a result of alternative targeting or intensity of damage to populated areas. The peacetime model uses demographic projections for the USSR prepared by U.S. experts. In SEMREC, however, the analyst determines population growth. A baseline assumption has been that in the first five years of recovery, the birth rate is completely offset by delayed fatalities and the population does not grow. Population growth is assumed to be 2% per annum in the next five years. At this stage of investigation, it would appear that the model can accept levels of population reduction anywhere in the range of interest indicated in recent literature. While preattack urban/rural population distribution would figure in estimating population reduction, SEMREC endogenously determines this distribution postattack, based on agricultural employment.

The specification of initial conditions with respect to damage to the capital stock requires the provision to the model of values for percentage reduction in capital stock in the initial year of recovery for

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each of the sectors of the economy and branches of industry. Simulations have been performed with levels of damage to the industrial capital stock ranging from 10 percent of the preattack stock to 50 percent. It will be further explained, in the section on model limitations below, that 50 percent reduction in industrial capital stock is about the maximum that the model should be asked to handle, i.e., above this level of damage many of the relationships specified in the model could be expected to break down; either the model might not be solvable or simulations with undue levels of damage might be unrealistic. This figure was obtained by looking at the structure of branch and sectoral capital stocks and aggregating maximum damage levels across them.

The reductions are not specified as uniform across branches and sectors. They have been distributed in a manner deemed concomitant with vulnerability and targetting priority hypotheses. Maximum levels of damage were deemed to vary from 20 percent in the cases of processed foods, forest products, soft goods, and coal products to 80 percent in the case of ferrous metallurgy. Damage levels for sectors other than industry are typically assumed to be a maximum of 20 to 30 percent. In addition, the ability of the software to solve the model in the face of extreme imbalance in surviving capital stock may be a limiting factor in specifying initial conditions. Such an imbalance could either prevent the model from converging to a solution or provide a solution that gives much lower levels of output than might be expected given the ability to substitute the bottleneck material inputs. The model should not be viewed as a black box by which specified initial conditions are transformed to a unique recovery path. It is rather a complex tool by which an analyst can observe the impact of various key parameters, including initial conditions, on potential recovery paths.

2. Recovery Objectives and Controlling Assumptions

Recovery objectives and controlling assumptions about economic decisionmaking postattack play a major role in influencing model solutions. These objectives and assumptions are incorporated in the model simulation through the setting of analyst levers. While the initial conditions, in a

sense, when coupled with the model, sketch out a frontier of production possibilities, the priorities, shares, etc., guide the model in choosing a product mix on (or possibly within) that frontier. In addition, through investment allocation and end-use share determination, the dynamic evolution of the frontier is determined. While a dynamic adjustment leadership decision system, which remains to be added to the model, would furnish an automatic correlation of objectives, performance and allocation decisions, the existing framework of analyst levers in SEMREC does give the user the opportunity to vary centralized decisionmaking behavior by setting targets that would be examined by the leadership.

An initial set of alternative recovery objectives might include:

o   Restore the economy along preattack lines wherever possible--maintain an emphasis on heavy industry.

o   Restore all branches of the economy in a balanced manner with increased priority over preattack for consumer sectors to generate goods for labor incentive.

o   Restore war-supporting industry, neglecting even the category of heavy industry not directly related to defense production.

These alternatives would not only relate to branch and sectoral priorities and investment shares but to other analyst levels relating to the economic environment -- labor participation, work week, consumption targets, etc.

3.   Analyst Intervention

The analyst intervenes in the model solution by setting values exogenously for key parameters or levers, or in some cases by altering the model specification. The analyst may intervene to create a coherent picture of a particular environment (set of recovery objectives and controlling assumptions) or to change one particular aspect of the

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environment and determine the impact on model performance. By means of model applications with alternative environments and exploring a spectrum of values for individual levers, the reasonable bounds to the variation of the values of those levers is established. The decision on the reasonableness of a solution is, of course, a matter of expert judgement on the part of an economist. The technical note on the analysis of a base case with SEMREC3A, also a product of this research contract, provides guidance to the analyst on interpreting model solutions.

Examples of the sorts of analyst intervention are useful. In the first example, the analyst sets a series of parameters and exogenous variables in order to create a coherent picture of postattack environment—in this case, one in which the political leadership does not have the control over the population (or finds it too costly) to enforce the degree of labor discipline one might expect in an emergency. This is one of the recovery environments under which model simulations have already been performed. To supply the features of this environment, the analyst:

o   decreases the level of labor force participation
     (the workers may not be idle, but working at
     activities deemed undesirable)

o   increases the share of investment in industry
     devoted to branches producing consumer goods

o   increases the targets for consumption in each of
     the four categories

o   if foreign trade is conducted, increases targets
     for trade flows including imports of consumer
     goods.

In initial simulations of the model, the assumption of this diminished political control variant had a similar impact on output of heavy industrial branches (relative to the baseline variant) to the impact of initial conditions with significantly greater damage to the industrial capital stock.

For the second example, assume the baseline variant with balanced priorities and investment shares based on the historical pattern (which already entails emphasis on heavy industry). The analyst may intervene in the simulation to introduce a higher share of output of the machinebuilding branch to be devoted to military durables procurement. Since the balance for available investment goods includes a direct tradeoff between available producer durables and military procurement, the model solution will reflect downward adjustment investment and/or positive adjustment to MBMW output. This represents the second type of intervention in which the impact of varying one controlling assumption on economic performance is examined.

C.   Interpretation of Results for Strategic Planning

It has been noted above that while SOVMOD was developed as a tool for forecasting as well as analyzing the performance of the Soviet economy, SEMREC simulations of potential Soviet postattack recovery would require careful interpretation, even if the initial conditions in model simulation corresponded to a real situation in all significant details.[1] It is necessary, then to state what the strategic planner can expect to learn from analysis via the SEMREC model.

The quantitative measures of economic performance in recovery provided by a simulation of the model, in turn, require interpretation for the planner if implications are to be drawn for comparative purposes, whether for comparison of alternative outcomes for the Soviet Union or for consideration of the outcome relative to the postattack U.S. economy.

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[1] It should also be noted that the SEMREC specification does incorporate much of the peacetime structure of the Soviet economy and many of the relationships are estimated with peacetime historical data (production functions, input-output relations, etc.). The appropriateness of these relationships to a recovery environment need also to be considered by the model user.

National power and US-USSR competition in the current environment cannot be reckoned from economic performance alone, but include military and political dimensions as well. The essence of an overall assessment by the political leadership of the state of the national economy, then, must be the ability of the nation to achieve leadership objectives in the military, political, and economic spheres. Hypotheses about Soviet leadership objectives postattack, beyond those incorporated in the model simulation, must be contingent on assumptions about war outcomes, military, economic, and political conditions among former and present adversaries and allies, and domestic political status. The modeling approach in the SEMREC project, while not ignoring the importance of these broader environmental considerations, intentionally avoided typing model specifications to a particular alternative or set of alternatives for the broad context of postattack objectives and decisionmaking.

The planner-analyst examines a set of assumptions about key parameters for impact on economic performance and then selects values concomitant with hypothesized objectives. Or, alternately, when the impact of varying sets of initial conditions is examined, their impact is assessed across changing sets of leadership objectives. In either process, economic performance, in terms of macroeconomic aggregates—end-uses of GNP, branch and sectoral outputs—must be evaluated from the point of view of national capabilities. While this interpretation might be aided by increased scope of modelling (e.g., translation of military capabilities into requirements for deliveries from the industrial sector and categories of defense expenditures), such capabilities were beyond the current scope of the research undertaken.

D. Model Limitations

1. Application Areas

SEMREC, first of all, requires the analyst to make explicit his assumptions about key parameters of a potential postattack environment. These assumptions undelie not only model performance but more important,

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they are used by the planner in converting strategic guidance into operational considerations and eventually critical decisions. The model serves as a framework to incorporate the assumptions about the postattack economy, in a consistent manner, to determine their implication for economic performance, and to provide a quantitative dimension to an analysis of the impact of the strategic planner's decisions on economic performance under alternative sets of assumptions.

Design considerations and the results of model experiments indicate that SEMREC is a useful tool for analysis with initial conditions in the moderate damage range. This range has been determined to be 0 to 50 percent reduction in industrial capital stock. The latter figure was calculated by aggregating the maximum damage levels for individual branches. By considering the capital structure of each branch, the vulnerability of that capital, and the point at which assumed economic relationships would break down, these individual figures were determined. They will be discussed in the initial conditions section of the following chapter on model structure. Only three variants of the profile of damage across branches and sectors have been examined, i.e., in most cases, when the level of damage has been varied, relative shares of reduction by branch 'ave been kept constant. The non-proportional variants have included greater relative reduction in the capital stock of war-supporting branches (machinebuilding, chemicals, and metallurgy) and increased damage to non-industrial sectors.

Limitations on the degree of imbalance in surviving capital stock among sectors and branches may be imposed by the balancing system, in which solutions would be implausibly low or the model would not converge to a solution. The introduction of slack into the material balances or relaxation of balancing for non-essential inputs to reflect substitutability among material inputs may be required to furnish an acceptable solution.

The initial conditions for population have been varied from about 10 to 35% reduction of total population. It would seem that this is an acceptable range for SEMREC analysis and is concomitant with reduction levels considered in recent interagency studies.

2. Technical Areas

The first technical area relates to the production functions. In SEMREC, these are Cobb-Douglas in log form. The choice of an appropriate form for production functions for Soviet industrial branches is currently a point of divergence of opinion in the literature. Cobb-Douglas production functions have performed the most satisfactorily in SOVMOD and thus were used in SEMREC. This form of production function sets the elasticity of factor substitution at unity (see appendix to this chapter for the presentation of this result). In essence, this formulation means that capital and labor are more readily substitutable than if a lower elasticity of substitution were specified (e.g., with a constant or variable elasticity of substitution function). Thus, output response to labor/capital imbalance is more optimistic in terms of output than possibly is justifiable in the Soviet case, and most probably in Soviet postattack recovery.

A number of other technical issues relate to the interpretation of output response to reduction in capital and labor inputs in the model. Labor inputs are currently undifferentiated by skill levels and differential productivity fo varying labor qualities may prove important, particularly if population reduction is not constant across skill levels (e.g., only about 20% of rural workers possess urban labor skills). Similarly the capital stock is undifferentiated. It is likely that surviving capital may be more concentrated at small-scale facilities postatttack, and small-scale production technology differs significantly from large-scale facilities which are also likely the most up-to-date. Lastly in this category, no provision is made for the evolution of technology over the recovery period.

The balancing mechanism assumes no substitubility in production between outputs of different branches of industry. Different outputs of the same branch are treated as a homogenous material. Since some assumptions of this nature must be made (i.e., a level of disaggregation chosen between one homogenous material input and the full range of differentiation of inputs to production), it is hoped that at this level of disaggregation the effects tends to cancel out.

Two other aspects of the balancing and adjustment mechanism should be included in this discussion. The final demand relationships, that is, the relation of levels of individual categories of final demand to final deliveries of each of the branches and sectors to those end-uses, must be regarded as first approximations. These relationships are used in the model to enter final uses of output into the balances based on endogenously and exogenously determined levels of GNP end-use (consumption, investment, defense expenditures, etc.). These approximations were made on the basis of Western reconstructions of Soviet I-O data for a base year. To establish dynamic patterns for final demand coefficients would require a significant research effort although such information would be valuable for a broad range of analysis. The impact on the functioning of the balancing system on output levels due to revised estimates of final demand relationships cannot be foreseen now.

Second, the balancing and adjustment mechanism is not now integrated with the investment allocation mechanism in the model. In order to break critical bottlenecks, investment shares must be reset by the analyst after observing the impact of balancing on outputs. Investment, of course, cannot break a bottleneck via reallocation of a given level in the current period, since the capital stock is augmented only in the periods following the investment, but bottlenecks should be considered in formulating investment programs. In an elaborated balancing scheme, investment would be realloacted in light of critical bottlenecks and an additional feature -- the measurement of the capacity of a sector to absorb labor should also be added to the model. This latter addition would tend to make higher output in high priority branches feasible as would analyst intervention in the allocation mechanism in response to bottlenecks.

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APPENDIX TO CHAPTER II

ELASTICITY OF FACTOR SUBSTITUTION WITH A
COBB-DOUGLAS PRODUCTION FUNCTION

We have the production function:

$$(1) \quad Y = A K^{\alpha} L^{1-\alpha}$$

to remain on the production possibility frontier we know the following must hold:

$$(2) \quad Y = L \cdot \frac{\partial Y}{\partial L} + K \cdot \frac{\partial Y}{\partial K}$$

The elasticity of factor substitution is the elasticity of the capital/labor ratio with respect to the marginal rate of substitution, or:

$$(3) \quad \delta = \frac{d \ (K/L) \cdot L/K}{d \left(\frac{dK}{dL}\right) \cdot \frac{dL}{dK}}$$

Solving for the capital/labor ratio from (2) we get:

$$(4) \quad \frac{K}{L} = \frac{\frac{\partial Y}{\partial L}}{\frac{\partial Y}{\partial K}} = \frac{Y/L}{\frac{\partial Y}{\partial K}} - \frac{dK}{dL}$$

and substituting from (1) we get

$$(5) \quad \frac{K}{L} = \frac{A \ (K/L)^{\alpha}}{A \ \alpha \ K^{\alpha-1} \ L^{1-x}} - \frac{dK}{dL}$$

and solving for K/L in terms of $\frac{dK}{dL}$

$$(6) \quad \frac{K}{L} = \frac{\alpha}{1-\alpha} \ \frac{dK}{dL} \qquad \text{so that differentiating}$$

$$(7) \quad \frac{d(K/L)}{d \left(\frac{dK}{dL}\right)} = \frac{\alpha}{1-\alpha}$$

and substituting into (3) we find

$$(8) \quad \sigma = \frac{\dfrac{\alpha}{1-\alpha} \cdot L/K}{\dfrac{dL}{dK}}$$

since

$$\frac{dL}{dK} = \frac{\partial Y/\partial L}{\partial Y/\partial K}$$

from (1) we differentiate and get

$$\frac{dL}{dK} = \frac{A \, \alpha \, K^{\alpha-1} \, L^{1-\alpha}}{A(1-\alpha) \, K^{\alpha} \, L^{\alpha}} = \frac{\alpha}{1-\alpha} \, L/K$$

and substituting into (8)

$$(8') \quad \delta = \frac{\dfrac{\alpha}{1-\alpha} \cdot L/K}{\dfrac{\alpha}{1-\alpha} \cdot L/K} = 1$$

While the coefficients on K and L are α and 1-α for easy calculation (i.e., constant returns to scale are assumed), the result does not depend on that assumption.

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III THE STRUCTURE OF SOVMOD AND SEMREC

A. Basic Framework

The structures described in this chapter relate to SOVMOD4 and
SEMREC3. The flow charts following indicate the basic structures of SOVMOD
and SEMREC. SOVMOD is basically supply driven. Branch and sectoral
outputs are determined by labor inputs based on exogenous population data,
capital inputs (determined by investment behavior), and agricultural
performance (deviations from "normal" production due to key weather
indicators). Production and past patterns determined wages, prices,
incomes, and, in turn, consumption. Foreign trade serves as a supplier of
inputs to and an outlet for production activity. The state budget, based
on annual published statements, influences the direction of investment.
Production activity determines GNP by sector of origin and consumption; the
budget, investment and net exports determine GNP by end-use. The
adjustment mechanisms relates sources of output (production) to uses
(interindustry use and deliveries to end-use categories) and outputs are
adjusted to insure balance.

SEMREC builds on this framework. The basic driving mechanism is the
same, but allocation of resources among productive sectors and allocation
of output among end-uses allows significant intervention by the center to
replace reliance on past patterns, wages, prices, the state budget and
incomes as allocational determinants. Foreign trade is exogenously set via
target functions rather than modelled along peacetime lines, inappropriate
for the recovery environment. The wage, price, income, budget and hard
currency of SOVMOD are included in SEMREC but in the recovery period can be
ignored[1] (see Table III-1 on model blocks following).

_____

[1] If the analyst chooses to set levers, for example, to use SOVMOD trade
   equations in SEMREC, these blocks do come into play, but this should be
   avoided for most of the recovery period. Wages, prices, incomes and
   budgets outlays are calculated according to peacetime relationships, but
   have no impact on other blocks in the recovery model.

Table III-1

MODEL BLOCKS

SOVMOD   SEMREC

Population and Employment   Population and Employment
Investment   Investment
Capital Formation   Capital Formation
Production   Production
Agriculture   Agriculture
Wages, Incomes, and Prices   Wages, Income and Prices*
Consumption   Consumption
Budget Revenues and Outlays   Budget Revenues and Outlays*
Foreign Trade   Foreign Trade*
Hard Currency   Hard Currency*
Aggregate Identities   Aggregate Identities
Energy (SOVMOD4 only)   Energy*
                                Gross Value of Output-Output*
                                Index Linking Equations
                                Balancing and Adjustment*

                                * SEMREC3A Only

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The SEMREC flow diagram[1] indicates the points in the model structure at which assumptions about the recovery environment enter the solution process. These elements are detailed in the following sections on the model components. A key to model nomenclature precedes the detailed descriptions of the components (Table III-2). Model structures are fully documented in the appendices to the guide.

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[1] Figure 2
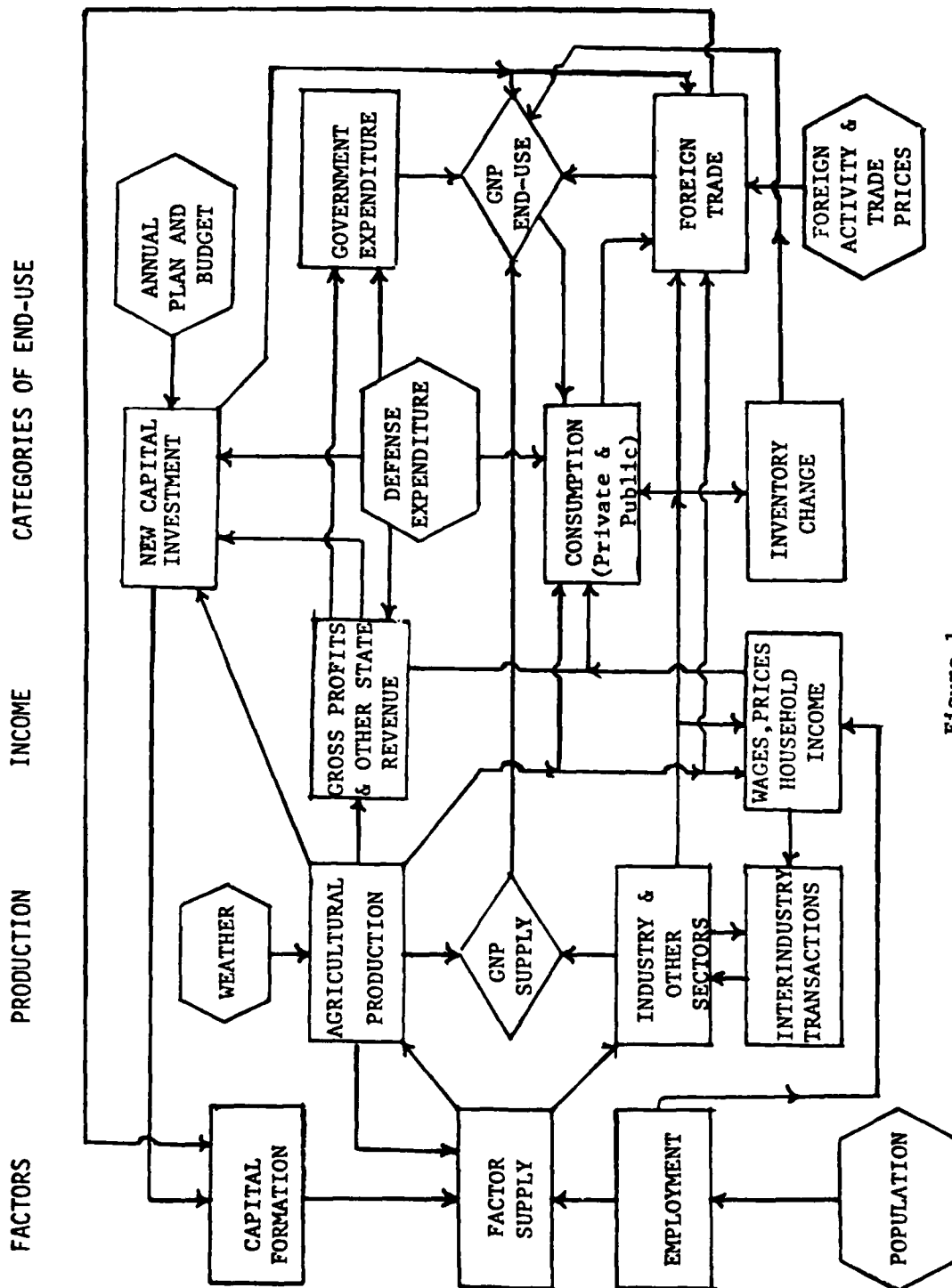
Figure 1

THE STRUCTURE OF SOVMOD III

Figure 2

SEMREC STRUCTURE

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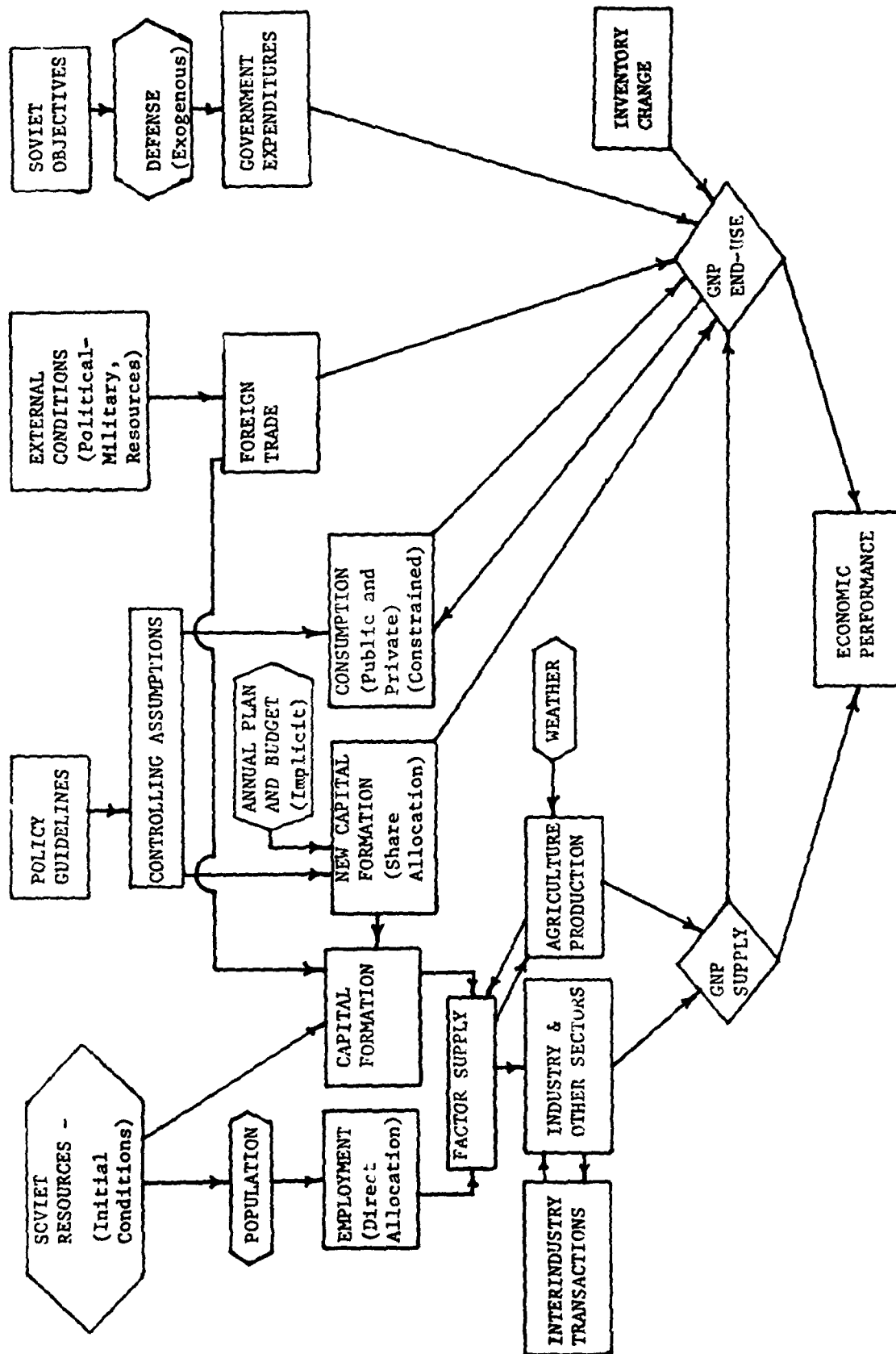
Table III-2

NOMENCLATURE OF VARIABLES - INITIAL SYMBOLS

SOVMOD and SEMREC

N	Population and Employment
I	Investment
K	Capital Formation
A	Agriculture
X	Production
U	Material Inputs
W	Wages
Z	Incomes
P	Prices
C	Consumption
T	Budget Revenues
B	Budget Outlays
E	Exports
M	Imports
F	Hard Currency
G	Aggregate Identities and Balances
Q	Dummy Variable
A.	Variable for Exogenous Adjustment to Solution Value
P.	Production or End-Use Target Before Balancing

Table III-2 (cont'd)

NOMENCLATURE OF VARIABLES - EMBEDDED OR TRAILING SYMBOLS

SOVMOD and SEMREC

Sectors

IN	Industry
CN	Construction
TC	Transportation and Communication
DT	Distribution and Trade
SV	Government and Services
A	Agriculture

Branches of Industry

EP	Electric Power
CP	Coal Products
PP	Petroleum Products
FM	Ferrous Metals
NF	Non-Ferrous Metals
CH	Chemicals and Petrochemicals
FP	Forest Products
PA	Paper and Pulp
CM	Construction Materials
MB	Machine-Building and Metalworking
SG	Soft Goods
PF	Processed Foods
NC	Not Elsewhere Classified

B. Labor Allocation Mechanisms

1. SOVMOD

Population data for the SOVMOD model (and SEMREC) are exogenously given from expert demographic projections by the U.S. government. The distribution of population between urban and rural regions is modelled and depends on the trend toward urbanization, housing construction (lagged), rural/industrial wage ratios (lagged), and the result of the previous year's harvest. The share of urban population which constitutes the urban labor force is also modelled, and depends on the age composition, real wage, urban population growth rate and a time trend. The share distribution of labor among sectors of the economy and among branches of industry is determined by past labor shares and investment rates. Thus the allocation follows past patterns unless the pattern is disturbed by changes in rates of investment in the sectors and branches.

Representative functional forms for labor block equations would include:

$$\frac{\text{Urban population}}{\text{total population}} = f_1 \text{ (investment in housing, industrial/rural wage ratio, state of the harvest, time)}$$

$$\frac{\text{Construction employment}}{\text{Total non-agr. employment}} = f_2 \text{ (industrial/total non-agr. employment ratio lagged, trade/total non-agr. emp. ratio lagged,... growth of non-agr. investment)}$$

$$\frac{\text{Electric power employment}}{\text{Industrial empl.}} = f_3 \text{ (MBMW/total industry employment ratio lagged,..., construction materials/total industry emp. ratio lagged, growth of non-agr., investment, time)}$$

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2. SEMREC

    a. Description

        While basic population data in SEMREC come from the SOVMOD
databank, (i.e., are exogenous) there are basic differences in the block.
First, in a SEMREC simulation other that the baseline, population data are
drawn from a data archive which specifies population losses. Secondly, the
labor force is determined simply by a participation rate which can be
changed exogenously. Third, the allocation of labor among sectors and
branches is determined by labor demand equations as a function of outputs
after balancing, material inputs and the sectoral and branch capital
stocks. These are then scaled by the ratio of total labor available to a
weighted sum of labor required for full capacity utilization in each sector
(dubbed necessary labor). Thus,

Total labor force   =   (Able-bodied Population)x(Participation rate)

Total necessary labor   = $\sum_i$(Demand for labor)$_i$

Labor for Sector$_i$ =   f(adjusted, output$_i$, material inputs$_i$, capital
                               stock$_i$)

Actual Labor for Sector$_i$ =   (Demand for labor)$_i$ x $\dfrac{\text{TOTAL LABOR FORCE}}{\text{TOTAL NECESSARY LABOR}}$

        This mechanism replaces the employment relations in SOVMOD
because it is assumed that in the postattack environment central planners
will directly control labor allocation based on the set of national
sectoral and branch priorities and the profile of surviving (reconstructed,
and augmented) capital stocks.

    b. Analyst Intervention

        Apart from specifying the initial conditions of the scenario in
the input data archive for the simulation (discussed under separate
heading), the analyst can adjust the labor participation rate NPART9. It
should be noted the 1975 rate that has typically been assumed is already
quite high.

For several sectors of labor allocation for which production functions do not appear, labor demand is calculated as the 1975 labor/capital ratio times the surviving capitol stock.

C. Investment and Capital Formation

1. SOVMOD

Capital investment in SOVMOD is represented by two alternative sets of equations. In the first alternative, investment in the six major economic sectors is modelled on growth in such variables as gross profits, the planning cycle (i.e., the year of the five-year plan then operative, nonpersonnel defense expenditures, total nonagricultural investment, the financing of centralized investment by the state budget (published along with annual plan targets) and the state of the harvest. Within industry, investment in branches is determined by these growth rates, as well as lagged growth rates for investment in branches of industry. This alternative is quite specific to the functioning of the peacetime economy and is not utilized in SEMREC simulations.

In the second alternative, total nonagricultural investment is modelled on the planning cycle, gross profits and defense spending, but the share of each sector and the share of the branches of industry within the industry total are exogenously set (in a baseline case -- along historical patterns). Agricultural investment growth depends on defense, harvest results, and growth in state financing of centralized investment.

Inventory changes, modeled separately for trade, and non-trade non-agricultural componenets, are a function of past stocks and lagged production of appropriate sectors, and for the case of trade, on consumption, the state of the harvest, and defense expenditures as well. Capital repair is determined by a time trend for its share of total capital stock.

Capital formation involves the adjustment of the capital stock of the preceding year by deducting depreciation and adding a weighted sum of lagged investment in the sector and branches. The capital formation equations also take into account the phase of the current planning cycle, since the completion of investment projects is accelerated at the end of

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the cycle and the effect spills over into the beginning of the next.
Imports of capital goods (machinery) are also explicitly accounted for in
the capital formation for the MBMW, chemicals and petroleum branches.

2. SEMREC

a. Description

In SEMREC, the investment allocation system is similar to the
second alternative in SOVMOD described above. All investment shares for
sectors and branches are set exogenously by the analyst. These shares of
total non-agricultural investment for the sectors, for non-agricultural
investment as a share of total, and branches as a share of total investment
in industry would diverge from historical values in accordance with
assumptions about changes in sectoral and branch priorities from those o
the peacetime economy. Inventory change and capital repair are specified
as in SOVMOD.

The above mentioned shares are applied to adjusted values for
investment aggregates non-agricultural investment (INA), machinery
component of agricultural investment (IAM), and construction component of
agricultural investment (IAC) which come out of the balancing adjustment
block (see section below and appendix which relate to that block). We are
concerned here with the determination of the unadjusted or target values
for these aggregates (P.INA, P.IAM, and P.IAC). In each case these targets
are a function of time and a base level for the variable. The default
values for the exogenous variables in the determination were derived from
regression analysis so that the equations reproduce historical trends. The
target functions are of the form

$$I^* = e^{w+zt} Io$$

where I^*= target for investment
t = time
Io= base level
z = growth rate
w = exogenous adjustment

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or for INA:

P.INA = EXP (DELTAINA + ZETAINA*QT50 + LOG (ETAINA))

QT50 = time trend

For the period starting with the year in which capital stock reductions are introduced, the model automatically reduces the Io by the same percentage as the machinebuilding sector capital stock. The historical trend is then resumed but growing from the new lower base over the recovery period.

In SEMREC3, capital formation equations do not appear explicitly, but are substituted into the capital stock equations in place of the capital formation variable. The substituted expression is identical to that for SOVMOD, except that parameters are introduced to reduce investment in place at the beginning of the recovery as it enters the capital stock in succeeding periods (see selection below on initial capital stock conditions). Capital repair is calculated as in the SOVMOD description above, but enters the balancing system and is adjusted.

b. Analyst Intervention

As indicated in the preceding section, the major levers for the analyst in the investment and capital formation blocks are the investment shares for the sectors of the economy and branches of industry. The historical shares reflecting peacetime allocation patterns (immediately pre-war) can be used as a point of departure. It should be noted that these historical shares already reflect priority for heavy industrial sectors and particularly machinebuilding and metalworking. Table III-3 identifies the investment shares for sectors and branches. These are stored in the SEMREC data archive and maintain the 1975 value throughout the period to 1985 (they are exogenous). These values are easily altered using data editing techniques described in Chapter IV. It is important to remember that the shares for all non-agricultural sectors must sum to one, and the shares for all industrial branches must sum to one since these are shares of total non-agricultural investment and total investment in industry, respectively.

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Table III-3

Investment Shares (default values set equal to 1975 levels generated
by SOVMOD)

IRCH9	IRINA9
IRCM9	IRIS9
IRCP9	IRIT9
IREP9	IRMB9
IRFM9	IRNF9
IRFP9	IRPF9
IRIC9	IRPP9
IRIH9	IRSG9
IRII9	

For example

IICP = (IRCP9)(IIN) , IIN = Investment in industry

IIN = (IRII9)(INA), INA = Non-agricultural investment

INA = (IRINA9)(ITOTAL)

The modification of the historical trend in the setting of targets for investment aggregates is also subject to analyst intervention. The DELTA _ _ _ variable may be used to alter the target for any one year without disturbing the trend. The ZETA _ _ _ variable can be altered to give more rapid or slower growth from the base-level. Detailed instructions on altering these variables are given in Chapter IV.

D. Production

1. Structure

a. SOVMOD IIIc

The specifications of production functions for branches of industry in SOVMOD IIIc were not of the conventional Cobb-Douglas or constant elasticity of substitution type but rather a rate-of-growth form. This specified an expansion path equivalent to a Cobb-Douglas concept, i.e.,

$$\Delta X_t / X_t = C_1 + C_2 \, (\Delta N_t / N_t) + C_3 \, (\Delta K_t / K_t) + \ldots$$

where X = output
N = labor input
K = capital input

These production functions also appear in SEMREC1.

b. SEMREC

Several major changes in the production block from the earlier SOVMOD specification were undertaken for SEMREC3. Because the I-O based balancing system works with gross value of output (GVO) of producing sectors, SEMREC3 production functions predict GVO rather than the CIA-OER output indexes which feed into the GNP calculations (also based on CIA's national account reconstruction for the USSR). The 1970 based output indices are determined by the adjusted GVOs via linking equations obtained by regressing the index series against historical GVOs, time, and shift parameters (dummy variables) to account for changes in price regimes.

Secondly, two-factor production functions have been replaced by three-factor (capital, labor, and material inputs) production functions of the Cobb-Douglas form. The factor-shares (actually used as exponents of supplied factors in this form) were constrained to be those actually

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observed in 1972 in producers' prices, while a parameter to determine returns-to-scale in the sector was estimated. The material inputs are determined by the input-output coefficients of the appropriate column in the series of balanced I-O tables in 1970 producers' prices and the output of the sector from the balancing/adjustment mechanism. The selection of the appropriate set of production functions involved the running of literally hundreds of regressions in order to determine the best formulation. These functions determine the initial set of outputs which are in turn adjusted by the balancing system.

A typical production function, for the metallurgy branch, and material input equation appear below. Each set of two equations for each producing branch and sector is solved as a simultaneous block by the models simulation process.

(initial) P.XIOME = EXP(C1ME + C3ME * (PGVOME * LOG(MINPUTME) + WGVOME
$$* \text{ LOG(NHRIND} * (\text{NMINF} + \text{NMIFM}) + (1 - \text{PGVOME}$$
$$- \text{ EGVOME)} * \text{LOG}(1.5 * \text{KIFM})))^{1}$$

MINPUTME = (A0101 + A0201 + A0301 + A0401 + A0501 + A0601
+ A0701 + A0801 + A0901 + A1001 + A1101 + A1201
+ A1301 + A1401 + A1501 + A1601 + A1701 + A1801)
* XIOME

where   P.XIOME   = gross value of output of metallurgy (initial)

XIOME   = gross value of output of metallurgy (adjusted)

C3ME   = estimated returns-to-scale parameter

MINPUTME = material inputs to metallurgy

NHRIND   = index of length of industrial work week

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[1] Note that a capital stock series for non-ferrous metallurgy is not available in the 1955 prices used by the model. Newly available data in 1973 prices indicate the capital stock of the combined metallurgy sector has consistently been 1.5 times that of ferrous metals.

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NMINF,
NMIFM    =  employment in non-ferrous, ferrous metallurgy

KIFM     =  capital stock, ferrous metallurgy

PGVOME   =  material input share of GVO, 1972

WGVOME   =  labor share of GVO, 1972

A0101, etc. =  input-output coefficients from metallurgy
                column of times series of I/O tables

C1ME     =  estimated coefficient
```

The factor-shares are derived from the reconstructed 1972 input-output table. The wage share is wages derived by GVO, the materials share is expenditures on material inputs of the sector divided by the GVO of the sector, and the capital share is assumed to be 1 minus the sum of the other shares. The input-output coefficients, the AIJ, represent the input of sector I in value terms required to produce one ruble of output of sector J.

c.   Analyst Intervention

Because the production sector is designed to represent technological relationships, analyst levers in this block are limited. The NHRIND index represents the length of the work week and thus the combined expression is a measure of effective labor input rather than just simply employment. The analyst can adjust this exogenous variable to represent extending working hours in the emergency period if desired. For example, the average industrial work week in 1976 was 40.7 hours. The index value for 1976 can be adjusted accordingly to be used as an assumption for the recovery period.

The analyst may also choose to alter the input-output coefficients over time. Currently, historical values for 1972 are kept constant over the simulation period. The analyst may feel an earlier year's technology would be appropriate given the reduction in capital

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stock. It should be noted, however, that the I-O tables are also used in the balancing routines and any change would be carried to that block as well.

E. Agriculture

1. Structure

The structure of the agricultural component is identical in SOVMOD and SEMREC (see Figure 3 following and note). Agricultural production is disaggregated into crops and animal products outputs. A grain component is separately identified from crop output, and meat production is similarly identified from animal products.

For total agricultural production, crop output, grain output, animal products, and meat production, both a normal and actual production equation appear. Normal production (a linked-second-peak data series) is a function of land, labor, capital, and materials inputs including feed. The deviations of actual production from the normal for total agricultural output, crops, and grain are functions of two weather variables—spring-summer precipitation and winter temperature. For animal and meat production the deviation of actual from normal is a function of the ratio of actual to normal grain and crop production, respectively, lagged one period.

An example of normal and actual output determination for a category is presented below to illustrate agricultural production relationships present in both the peacetime and recovery models:

Normal grain production:

Log (XGRTN-A.XGRTN)-C666*LOG((NASK+NASK(-1)-NASK(-2))/3.)-C855*LOG
(AVCP70)=C662+C663*LOG(ASGR9)+C664*LOG(KAIR)

where   XGRTN   = normal grain production
            NASK   = employment in state and collective agriculture
            AVCP70 = value of agricultural current purchases
            ASGR9 = area sown to grain
            KAIR   = agricultural capital stock
            A.XGRTN = exogenous adjustment

Figure 3
THE AGRICULTURAL SECTOR IN SOVMOD III AND SEMREC

Links are simultaneous unless denoted by the lag operator: L(1,2)
indicates a one and two-year lag. Hexagons indicate exogenous variables.
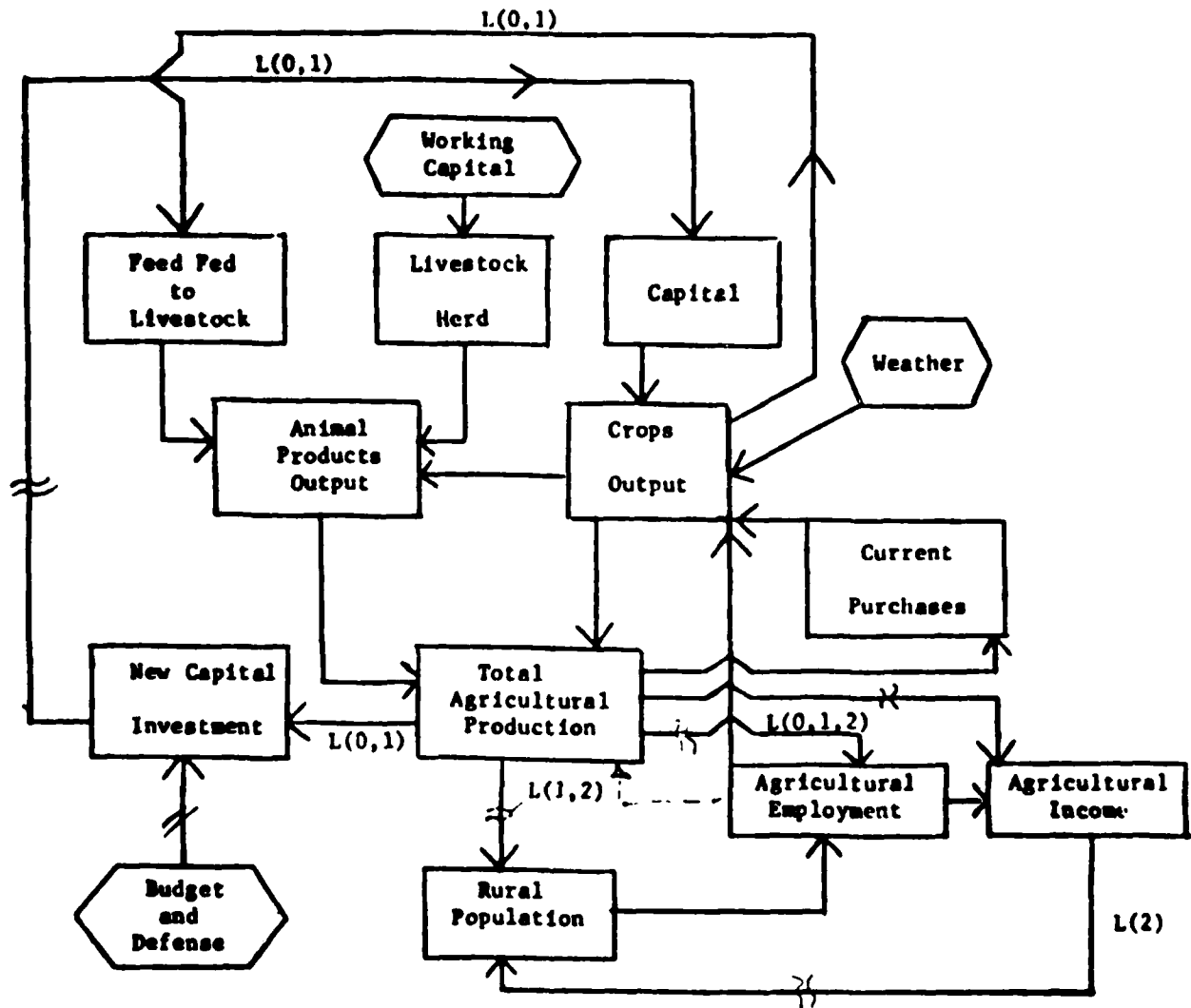
NOTE: Although the agricultural components of SOVMOD and SEMREC are
identical, the breaks in the arrows indicate links to other components that
are not present in SEMREC because of the modified labor and investment
allocation mechanisms.

Actual grain production:[1]

$$\text{Log (XGRT-A.XGRT)-Log XGRTN} = \text{C665+C637 JPS9+C638 JTW9+C639+}$$
$$\text{Q65+C640 Q75}$$

where

    XGRT = actual grain production
    JPS9 = spring-summer precipitation index
    JTW9 = winter temperature index
    Q65,Q75 = dummy variables

2. Analyst Intervention

The central exogenous variables affecting agricultural production in SEMREC are the weather indices. Currently three sets of weather conditions have been defined for scenario purposes (values for indices describing a five-year weather pattern):

o above-normal conditions   pattern of index values encountered in
                                   1966-1970

o below-normal conditions   pattern of index values encountered in
                                   1961-1965

o normal conditions   sample mean of the variables for
                                   1959-1972

With SEMREC, to date, only normal weather conditions have been used. In addition to the weather variables, some assumption may be introduced by the analyst as to reduction in sown acreage (ASGR9) in the recovery period. These data series are available to the terminal operator. Projected data for these series were developed for a baseline forecast with SOVMOD III to 1990. Data series for these variables may be obtained by the analyst and altered via the data manipulation techniques described in Chapter IV.

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[1] Note however, that a separate GVO production function for agriculture also appears to provide an initial value for balancing and adjustment.

F. Consumption

1. SOVMOD

In SOVMOD and in SEMREC, consumption is disaggregated into four subcomponents:

- o   food
- o   non-durables
- o   durables
- o   services

There are three alternatives in SOVMOD for determining aggregate consumption and the four subaggregates. In the first alternative, the share of real disposable income spent on each of the subcomponents is modeled directly and the aggregation is then accomplished. These shares depend on disposable income (or its growth), relative prices, and ratios between output of appropriate branches (e.g., processed foods, soft goods) and disposable income. In the case of durables consumption, the ratio between defense expenditures and household income is also included as an independent variable.

In the second alternative total consumption as a share of disposable income is modeled as above, while the shares of subcomponents of consumption in total consumption are modeled on lagged shares, relative prices, total production, farm income and non-personnel defense spending. The third alternative determines total consumption as a residual end-use of GNP with subcomponent shares of the total determined as in alternative two.

In SEMREC3, still another alternative is used, one based upon the notion that the leadership will set targets at the minimum deemed necessary to maintain labor incentives. The analyst therefore sets the target function for each category of consumption (food, non-durables, durables, and services) by selecting a share of pre-attack per-capita consumption in that category to be maintained. The initial per-capita consumption is allowed to grow over the recovery period at an analyst-determined rate (the default value is the

historical trend). The balancing mechanism ensures that adjusted outputs of consumer goods branches will be concomitant with adjusted levels of consumption.

A typical consumption:

$$P.CRD70 = EXP (LOG(NPOP9) + LOG (GAMMAD) + BETAD*QT50 + LOG (0.011))$$

where P.CRD70 = unadjusted durables consumption

NPOP9 = total population

GAMMAD = desired share of 1975 per capita consumption of durables

QT50 = time trend

BETAD = growth parameter for consumption of durables, per-capita

The last term in the equation above contains the figure for per-capita consumption of durables in 1975 in billions of 1970 rubles per million population.

2.   Analyst Intervention

The primary focus for analyst intervention in the consumption block is the setting of initial shares to be maintained of 1975 per-capita consumption in each category. The analyst may also choose to alter the growth parameter (it can be zero for a number of years if desired). These levers are exogenous variables and a value must be supplied for each year. Using the default values (that is not superseding the values stored in the basic data archives supplied with the model) results in an extrapolation of historical consumption trends.

If the targets for consumption in a given simulation result in a larger adjustment to outputs of consumer goods branches than the analyst deems appropriate (a crude rule of thumb is that a consistent 20% adjustment is too large), the analyst will want to revise targets for the

next simulation. Alternatively, labor allocation priorities and investment shares for consumer goods branches may be altered. Chapter IV provides details on setting parameters in target functions, and altering the latter analyst levers.

The main feedback on the rest of the model from the consumption block is through the balancing mechanisms. Final deliveries to consumption categories are deducted in the balances for output and inputs for the industrial branches. There is currently no labor supply function responsive to consumption incentives. These may be provided by the analyst via adjustment of the exogenous labor participation rate and/or the index for length of the work week to indicate labor response to increased incentives.

G. Energy Component

1. Structure

The energy component[1] is identical for SOVMOD and SEMREC. The energy
component consists of three sets of equations:

- o   energy demand and fuel requirements
- o   input and output levels for fuel branches
- c   foreign trade in energy

Forecasts of energy demand are made on production and population
levels from the other blocks of the model. Energy demand is classified
into electric power, thermal energy, and direct motor power. Equipment
technology dictates the type of fuel required and substitutability of fuels
and thus fuel demand is generated from energy requirements. It is assumed
that capital stock already in place will not have an altered mix of fuel
requirements so the average fuel mix coefficients are weighted averages of
the fuel mix required by the vintages of capital still in use. The fuel
mix for new capital investment is exogenously set by means of detailed
expert analysis. The capacity of atomic and hydroelectric power stations
are exog:nously given and thermoelectric power required is a residual. The
production of electric power is equated to the demand. This is justified
because the demand equations incorporate generation capacity constraints.
Some examples of this set of equations are illustrative:

Industry Use of Electricity

$$\frac{UELIN}{EPRIND} = 1.1090 - 0.1806 * \frac{XELP}{KELPC} + 0.16726 * \frac{KITOT}{XOIN}$$

---

[1]See Figure 5

INVESTMENT IN ELECTRIC POWER INDUSTRY

ATOMIC POWER PLANT OUTPUT

HYDRO-ELEC. PLANT OUTPUT

FUEL MIX PROFILE OF NEW CAPITAL

ELECTRIC POWER GENERATION CAPACITY

PRODUCTION OF ELECTRIC POWER

OUTPUT OF THERMAL-ELECTRIC POWER PLANTS

TOTAL FUEL INPUT TO THERMAL-ELEC. POWER PLANTS

GAS

HEAVY PETROLEUM PRODUCTS

CAPITAL STOCK REPLACEMENT IN ELECT POWER IND

COAL

THERMAL-ELECTRIC POWER

Non Fuel Use

GAS & PETRO PRODS FEEDSTOCKS

OUTPUT OF CHEMICALS INDUSTRY

COAL INPUTS TO COKING

COKE INPUT TO FERROUS METALS INDUSTRY

POPULATION & DOMESTIC ECONOMIC ACTIVITY

NON-TRANSPORT USE OF MOTOR FUELS

TRANSPORT ACTIVITY BY MODE

TRANSPORT USE OF MOTOR FUELS

PETROLEUM PRODUCTS

COAL

MOTOR FUEL

CAPACITY OF COMBINED THERMAL & ELECTRIC PLANTS

THERMAL OUTPUT OF COMBINED POWER PLANTS

REQUIREMENTS FOR THERMAL POWER

THERMAL OUTPUT OF BOILERS & FURNACES

TOTAL FUEL INPUT TO BOILERS & FURNACES

CAPITAL STOCK REPLACEMENT IN INDUSTRY

GAS

HEAVY PETROLEUM PRODUCTS

SECONDARY SOURCE HEAT

FUEL MIX PROFILE OF NEW CAPITAL

COAL

BOILER & FURNACE USE

A SIMPLIFIED DIAGRAM OF
THE ENERGY & FUEL CONSUMPTION SECTOR IN SOVMOD III

Figure 4

where UELIN   = use of electricity by industry

     EPRIND   = industry output index in which branch outputs are weighted by electric power requirements

     XELP   = total production of electric power

     KELPC   = total electric power generating capacity $\frac{XELP}{KELPC}$ represents the generation capacity constraint)

     KITOT   = total industrial capital stock

     XOIN   = industrial output $\frac{KITOT}{XOIN}$ is the capital/output ratio)

Total Electric Power Production –

     XELP   = UELIN + UELAG + UELTR + UELHHM + UELCN + UELOSS + EFTEP

where UELAG   = use of electricity in agriculture

     UELTR   = use of electricity in transport

     UELHHM   = use of electricity by urban households and municipal use

     UELCN   = use of electricity in construction

     UELOSS   = transmission loss

     EFTEP   = export of thermoelectric power

Electric Power Generating Capacity –

$$\frac{KELPC}{KIEP} = 13.878 - 2.91823 \ast QLT50$$

where KELPC   = electric power generating capacity

     KIEP   = capital stock of the electric power branch

     QLT50   = log time trend

Fuel Use in Thermoelectric Power Plants –

$$\frac{UFXELTP}{XELTP} = 0.4568 + 0.15 \ast (UCOXELTP/XELTP) - 0.12208 \ast (QLT50 - 3.2581)$$

where UFXELTP = fuel use in thermo-electric production

UCOXELTP = coal use in thermo-electric production (this term is merely an adjustment to the data which overvalues coal in conversion to standard fuel equivalents)

Gas Use in Thermo-electric Plants -

$$\frac{UGAXELTP}{UFXELTP} = CMGAE9 \left(\frac{KELTPC - 0.98 KELTPC_{-1}}{KELTPC} \right) + \left(\frac{UGAXELTP_{-1}}{UFXELTP_{-1}} \right) + 0.98 \left(\frac{KELTPC_{-1}}{KELTPC} \right)$$

This equation calculates the share of gas use in fuels for thermo-electric power by weighting the gas use coefficient for new capital (CMGAE9) and the lagged average use coefficient by the new capital and lagged capital shares of the total production capacity (KELTPC). A 2% rate of annual depreciation is assumed.

Total Coal Use -

UCO = UCOXELTP + UCOBF + UCOMF + UCOKE

where UCONT = use of coal

UCOXELTP = use of coal in thermo-electric power generation (coefficients correct for conversion from fuel equivalents to natural uses, losses, and internal uses in this equation)

UCOBF = use of coal in boilers and furnaces

UCOMF = use of coal as motor fuel (e.g., in locomotives

UCOKE = use of coal for coke

Output and factor allocation:

New employment and investment equations for petroleum products (gas + oil) were inserted in the appropriate blocks of SOVMOD and linked to output determined in the energy component. In SEMREC, the petroleum products labor and investment allocation are identical to that for other branches of industry. For coal production in SOVMOD, existing production and factor

allocation functions were used in value terms and linked to physical output for the energy component. Some examples

Gas output –

$$\frac{RXTGAN*XTGAN}{HPTGA} = 3109.18 - 720.01 + \frac{XTGANUE}{P.XTGAN}_{-1}$$

where   XTGAN   =   gas output in natural units

           HPTGA   =   total length of gas pipeline

           XTGANUE   =   gas production east of the Urals (P.XTGAN-XTGANEU is a function of a time trend)

           RXTGAN   =   damage factor for gas production (see initial conditions)

Petroleum Products Output[1] (value terms) –

$$XOPP = (0.6093 \frac{XTOIP}{353.039} + 0.3907 \frac{XTGAN}{197945.})*100$$

where   XOPP   =   potential petroleum products output

           XTIOP   =   total oil production in natural units

The energy component does contain endogenous determination of exports of energy and fuels. Exports of fuels are separately determined for CMEA (Eastern Europe) and the Rest of the World. Exports are a function of economic activity in the importing region, the Soviet hard currengy position, and prices. Prices for exports to the Rest of the World are exogenous, and to Eastern Europe are a function of lagged price and Rest of the World price.

---

[1]   See Figure 6
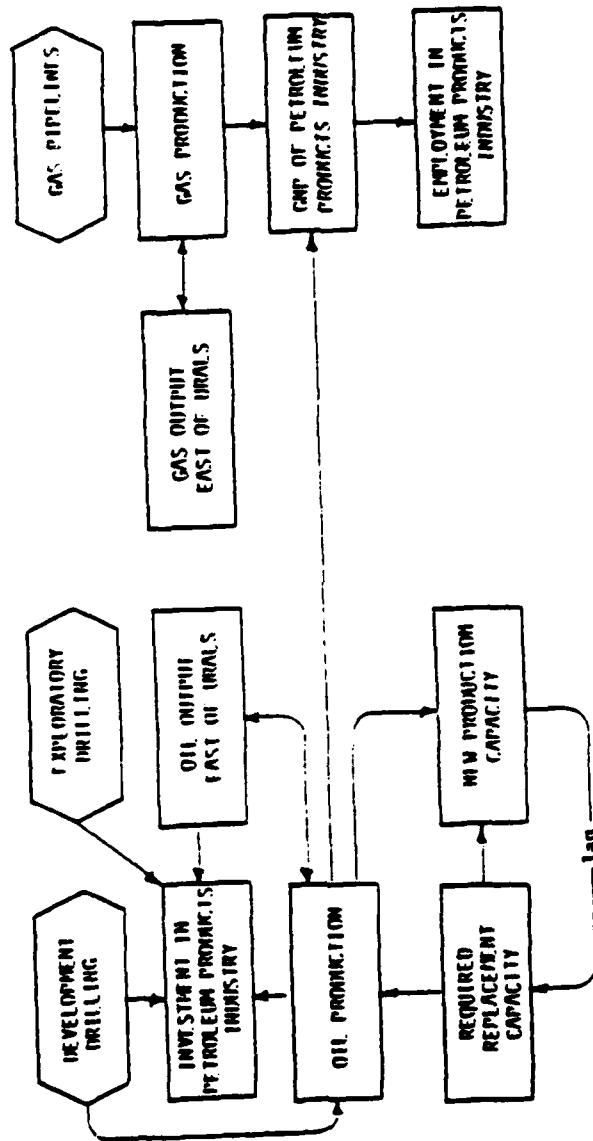
RELATIONSHIP OF THE PETROLEUM PRODUCTS
PRODUCTION VARIABLES

Figure 5

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The fuel sector outputs are translated via linking equations to
initial GVOs for use in balancing. The initial GVOs, that is, outputs in
value terms, are adjusted. The initial GVOs are P.XIOOI (oil), P.XIOGA
(gas), P.XIOCP (coal and peat).

2.   Analyst Intervention

Policy variables for recovery environments do not play a major
direct role in the energy component, but indirect links via other blocks of
the model (labor allocation, etc.) are maintained.

H. Balancing and Adjustment Mechanism

1. Structure

The structure of the balancing systems added to the SOVMOD and SEMREC models are identical. The sets of equations include:

o   Final demand definitions which translate
    unadjusted end-use items calculated in various
    model blocks into a consistent set of final
    demands based on input-output concepts required
    for balancing against gross values of output

o   Inventory and "other final demand" equations which
    calculate entries for the balances based on
    historical relationships between this category and
    levels of and changes in gross values of output
    (specifications are based on standard inventory
    adjustment arguments)

o   Balances which require the sources and uses of
    outputs of producing sectors and branches to be
    equalized

o   Adjustment equations which derive adjustment to
    initial outputs and end-use that will provide
    balance as well as minimize the weighted cost of
    the adjustments (weighted sum of squared
    deviations from initial values)

o   Translations which reverse the process of the
    final demand definitions and convert adjusted I-O
    based end-use categories back into model
    categories reflecting now the impact of balancing
    and adjustment.

The balancing system is an algorithm in which the outputs of sectors and branches as determined by primary factor inputs (i.e., in the production functions) are adjusted to insure that the uses of production for final demand and as inputs to the production process are equal to the output produced for each branch and sector. These adjustments are made in a particular manner--to minimize a quadratic function of the deviations between potential and adjusted output, where the deviations are weighted by leadership priorities. This process is intended to resemble the method of "material balances" by which Soviet planners insure consistency in plan

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targets. Priorities are considered by the planners when targets are adjusted to provide balance. A quadratic function is used to make adjustment more smoothly, so that small changes in variables do not result in drastically different solutions. Coefficients from Western reconstructions of Soviet input-output tables are used to calculate material input requirements for production and with some adjustments, final delivery shares of branches and sectors in various categories of end-use (i.e., consumption, investment, military procurement, etc.).

The description of the balancing technique and the formulation of final demand definitions is very complex and quite technical. The reader desiring further detail is referred to Appendix I. In this appendix, each set of equations described briefly above is presented.

2.   Analyst Intervention

The major analyst input into the balancing routine is the setting of the priority weights on individual adjustments to initial values for outputs and end-uses. If the effect of balancing and adjustment produces a model solution which adjusts away from a target which the analyst prefers to insist on meeting as closely as possible, he may increase the weight on that adjustment relative to all other weights. This increases the "cost" of making an adjustment to that target and a new simulation should provide a more satisfactory solution. These are the weights A01 through A40 which are stored as constants. Instructions in detail are provided in Chapter IV. As mentioned, above, this balancing and adjustment routine approximates the method of "material balances" used by Soviet planners to arrive at balanced plans according to given priorities.

I. Aggregate Identities

1. Structure

The aggregate identities close the model (both SOVMOD and SEMREC) and calculate aggregate measures of economic performance useful for the analyst. These include:

o   Agricultural GNP--total agricultural production less material purchases

o   Non-agricultural GNP--the sum of outputs of the nonagricultural sectors

o   GNP--the sum of the preceding two aggregates

o   Non-agricultural and total GNP per capita

o   Net material product (sum of non-service outputs)

o   GNP by end-use (excluding consumption--used to calculate total consumption as a residual end-use).

2. Analyst Interpretation

In model applications to recovery issues, it has been found that non-agricultural GNP is perhaps the most appropriate measure of aggregate performance beyond industrial production. This is true because the large share of agriculture in Soviet GNP and limited impact of the initial conditions on agricultural insure that a sixeable portion of gross national product is unaffected through changing initial conditons.

J. Other SOVMOD Blocks

1. Blocks Omitted from SEMREC

There are blocks in SOVMOD which model prices, wages, and income and the State Budget. While these endogenous variables play a role in peacetime allocation and consumption, they have been included in the recovery model, although central intervention replaces their role in decentralized decisionmaking. In addition, SOVMOD has a block which models hard currency transactions. These relationships specified and estimated according to peacetime experience, appear in SEMREC so that when certain equations, such as for foreign trade, use a peacetime formulation according to the analysts instructions appropriate endogenous variables required by the model are calculated. In other cases, they may be ignored.

2. Wage, Price and Income Determination and the State Budget

The key variables in the SOVMOD wage block relate to the industrial wage, the wage for state farm workers, and the wage for collective farmers. The variables are the real wage divided by output per worker in each of three sectors and they are a function of their own lagged value (and for industry - the state of the harvest). All other wages (industrial branches and other sectors) are tied to time trends and/or the industrial wage or theirr own lagged values. Thus, wage patterns tend to be extrapolated into the future, although tied to the industrial wage.

Consumer and most wholesale prices depend on their own lagged value, time trend, and the ratio of industry wage to output per worker. Non-food consumption price also depends on the turnover tax rate. Consumer food price depends on grain imports and the state of the harvest. Investment deflators, depending on a construction activity price deflator and heavy industry wholesale prices, are calculated for major sectors and the GNP deflator is a function of time and a dummy variable for price reform.

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Most incomes are set equal to average wage multiplied by employment. Gross profits are important for investment determination and depend on a time trend and the state of the harvest (there is an alternative specification depending on GNP and other revenues). Real disposal household income is calculated and play an important role in SOVMOD consumption functions.

Budget revenues and expenditures are also modeled in SOVMOD. There are four components of revenues: state enterprise revenues, turnover taxes, social sectors revenues, and wage and salary taxes. These revenues depend on tax rates, dummy variables representing legislated changes, and in the first two cases, the share of defense in government expenditures.

Budget outlay components include financing of the national economy, social and cultural measures, science, administration, and a residual category. The growth rates of these components are functions of time trends and in some cases growth of wages in government and services, growth in other budget outlays, and the state of the harvest. Defense expenditures are exogenously given. The most recent defense estimates by Professor Stanley Cohn of the State University of New York at Binghamton are used in the current version of SOVMOD.

Note: Two categories of budget expenditure and defense procurement are required in SEMREC3 so that all uses of output are included in the balancing. Defense procurement is calculated on the basis of historical relationship between output of machinebuilding and military durables expenditures. This is described in the appendix on balancing under the section on "other final demand categories."

The budget items for "research and development" (BRD) and "administration and other" (BAO) are calculated by target functions and are then adjusted by the balancing mechanism. The equations are:

$$P.BRD = EXP (NUBRD + IOTABRD*QT50 + LOG (SIGMABRD))$$
$$P.BAO = EXP (NUBAO + IOTABAO*QT50 + LOG (SIGMABAO))$$

where P.BRD, P.BAO = initial targets for respective budget outlays

IOTAs = growth parameters
SIGMAs = base values
NUS = exogenous adjustments (default = 0)

K. Foreign Trade

SOVMOD export, import, and hard currency relations are depicted in Figure 7.

1. SOVMOD

Exports are determined separately by geographical destination and several of these geographic subdivisions are further disaggregated by type of commodity. The geographic subdivisions are: Developed West, CMEA (Eastern Europe only), Other Socialist Countries (China, Yugoslavia, North Korea, etc.), and Less Developed Countries. Categories of exports to CMEA include: raw materials and semi-fabricates, non-grain food and manufactured consumer items, grain, machinery and equipment, and others. These exports by category are functions of CMEA grain production and population, the Soviet harvest, and world and domestic prices.

Categories of exports to the Developed West are machinery, other manufactures, fuel, food (non-grain), grain, and other. Grain exports depend on domestic and Western European grain production and Western European population. Food exports depend on world prices and domestic crop output. Machinery exports depend on the Soviet hard currency position and the ratio of CMEA to world prices. The other categories of exports to the Developed West are functions of relative prices and Western European economic activity. Other geographic sub-divisions of exports depend on extrapolating historical patterns with adjustments for the balance of payments and world trade levels.

Imports have the same geographic breakdown as exports. Imports from CMEA also have the same commodity categorization (without grain) as do exports. The imports from CMEA are functions of their own value lagged, Soviet exports of raw materials and semi-fabricates, Soviet food and soft goods consumption, and the trade balance.

A SIMPLIFIED DIAGRAM OF
THE FOREIGN TRADE SECTOR IN SOVMOD III

Figure 6

Imports from the Developed West are grouped into machinery (a function of Western prices, hard currency position, and level of Soviet investment), consumer goods (function of the share of durables in consumption, and the share of grain in total imports), and grain. Grain imports depend on domestic grain output, world prices, and a time trend. Four categories of machinery import from the Developed West (for total industry, for metalworking, for mining, metallurgy, and petroleum, and for chemical production) are separately modeled. They depend on investment levels, hard currency position, prices, and the timing within the five-year plan cycle. Other geographical imports flows depend, in general, on own lagged values, the balance of trade, and world trade activity.

The hard currency block calculates balances based on foreign debt, hard currency trade, gold production and sales, and hard currency reserves. This block largely consists of identities, with interest payments and credit repayments modeled on foreign credit drawings.

2. SEMREC

SEMREC provides hybrid foreign trade equations. It should be noted that in early versions of SEMREC foreign trade was completely exogenous. In SEMREC3, the same foreign trade structure is provided as in SOVMOD. Target functions for foreign trade subaggregates which will enter the balancing system are provided, however. It is useful to look at a typical equation for foreign trade before proceeding with the description, for instance, for exports of machinery to the Developed West.

$$EMADW-A.EMADW = MU6*(C1047 + C1048*(FDEBT-FSTK) + C1049*$$
$$PM1HU59/PM1DWP9) + KAPPA6*EXP(PSI6 +$$
$$RHO6*QT50 + TAU6)$$

The section of the equation multiplied by MU6 is the SOVMOD formulation based on hard currency variables (FDEBT and FSTK) and relative prices received for imports. The section multiplied by KAPPA6 is a target function for exports in this category. In this expression PSI6 represents the natural log of a one-time deviation in exports, RHO6 is a growth parameter (QT50 is a time trend) and TAU6 is a base level for exports in

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this category. Default values for these variables reproduces historical trends.

The values predicted by these equations are aggregated by commodity type to provide initial end-use estimates for foreign trade in the balancing mechanism. These are then adjusted to ensure balance.

3. Analyst Intervention

By setting the MUs equal to 0, the analyst invokes the target function. Conversely setting the KAPPAs equal to zero invokes the SOVMOD formulation. Since the SOVMOD formulation for foreign trade relies heavily on hard currency conditions and prices, for the emergency period it is probably not appropriate.

Since the target functions reproduce historical trends if default values for the PSI, RHO, and TAU variables are used, setting the KAPPA at some fraction less than one (MUs should be set to zero) sets targets for foreign trade at a share of the extrapolated peacetime trend. The fractions can be differentiated by commodity type and trading region. If desired, the growth parameters (RHOs) and exogenous derivative from trend (PSIs) can also be manipulated. Chapter IV provides detailed instructions on altering these parameters, which are stored as exogenous data.

The following foreign trade flow targets can be adjusted by the analyst:

Reference Number	Variable	
1	ENFRMCM	exports, non-fuel raw materials to CMEA
2	EMACM	exports, machinery, to CMEA
3	EGRCM	exports, grain, to CMEA
4	ECOCM	exports, consumer goods, to DEMA
5	EFUELDW	exports, fuels to Developed West
6	EMADW	exports, machinery to Developed West
7	EOMDW	exports, other materials, to Developed West
8	EODW	exports, other, to Developed West
9	EGRDW	exports, grain, to Developed West
10	EFODW	exports, food, to Developed West
11	ETLDC	exports, to LDCs
12	ETCH	exports, to China
13	EOSC	exports, to Other Socialist Countries
14	ECUBA	exports, to Cuba
15	MRMCM	imports, raw materials, from CMEA
16	MMACM	imports, machinery, from CMEA
17	MFOCM	imports, food from CMEA
18	MCOCM	imports, consumer goods, from CMEA
19	MMADW	imports, machinery, from Developed West
20	MRMDW	imports, raw materials, from Developed West
21	MCODW	imports, consumer goods, from Developed West
22	MTLDC	imports, from LDCs
23	MOSC	imports, from Other Socialist Countries
24	MTCH	imports, from China
25	MCUBA	imports, from Cuba
26	EFUELEE	exports, fuel to Eastern Europe

L. Incorporating Initial Conditions

1. Population

This section will describe how initial conditions enter into the model simulation. Population initial conditions are furnished to the model simulation through the construction of exogenous data series generated by the analyst.

It is possible with the TROLL software system to file series in the data bank in a particular archive. If the proper command is given prior to a simulation, the computer goes to each archive, in the order specified, to search for the data needed in the simulation. If a value is found for a particular variable in one archive, the computer looks no farther for that piece of data. Thus, by asking the computer to search an archive with a particular set of initial conditions first, the data is used instead of values for the same series stored anywhere else in the files. In this manner initial conditions for a recovery scenario replace exogenous values used in the baseline (no damage) forecast. This system of archives is used, as well, to specify initial conditions for capital stock and to select a foreign trade package. The procedure for building and selecting archives for model simulations is detailed in the terminal users' section.

Three sets of population initial conditions archives are already in existence in the data files provided with the model. They relate to no civil defense measures taken (about 31% reduction in population), some civil defense measures effective (about 24% reduction) and effective civil defense (about 16% reduction). Since these series are for exogenous variables, values for each year of the stimulation period must be specified. Therefore assumptions were made about population growth, i.e., no growth in the first five years (delayed fatalities equal birth rate) and 2% growth in the second five-year period of recovery.

The initial conditions archives contain series for two exogenous population variables--total population (NPOP9) and able-bodied population (NPOPAB9)--covering the ten-year recovery period. Since in SEMREC as well as SOVMOD, labor force data relies on exogenous population projections, population reductions are thus introduced throughout the model. Alternative sets of initial conditions are readily generated by the analyst by adjusting population data series stored in the model's files.

2. Capital Stock

Initial conditions for capital stock are similarly entered into the simulation process via archived data. Algorithms have been entered into the model to calculate impacts of percentage reductions in capital stock on values for simulation. Therefore, the analyst need only enter a value for the fraction the capital stock is reduced by for appropriate branches or sectors. It should be noted that in earlier versions of SEMREC it was necessary for the analyst to calculate initial capital stocks as well as reductions in investment in place.

The following is a typical capital stock equation, for the chemical branch:

$$\text{KICH-A.KICH} = (1-\text{DBAR}(-1)*\text{DKICH}(-1))*(\text{KICH}(-1)-\text{C211}*\text{KICH}(-1)) + \text{C209}*(\text{QFYP}(-1)-\text{C478}) + \text{C210}*\text{RKN3ICH}* \text{IICH}(-3) + \text{C210}*\text{RKN2ICH}*\text{IICH}(-2)$$

The first part of the equation takes last years capital stock (KICH(-1)) and less depreciation (C211*KICH(-1)) and multiplies it by the capital stock reduction factor, (1-DBAR(-1)*DKICH(-1)) for chemicals. DKICH(-1) is the fraction of reduction (e.g. by 10%, DKICH=.1) while DBAR is a means to increase (multiply by a constant factor) the level of reduction for all sectors without changing the sectoral profile of the reduction (DBAR is set to 1 by default). To this expression is added the expression for capital formation in the branch last year to give initial past years (the lag structure differs from sector to sector) and the planning cycle (QFYP). It can be noted that RKN_ _ _variables are automatically calculated by the model based on the DK_ _ _values supplied

by the analyst so that investment in place at the time of the capital stock reduction is concomitantly reduced, even though the investment does not augment the capital stock until later years.[1] The complex set of definitions for the investment pre-multipliers which appear at the beginning of the model are required because of the complex and variable lag structure in capital formation in various sectors.

The only exception to the above introduction of capital stock reductions applies to production of gas and oil in the energy component. These production equations in physical terms are not dependent on the value of capital stock. Therefore separate multipliers are required to simulate effects of reduced capital stock on these physical outputs. These are RXTOIP (physical oil output modifier) and RXTGAN (physical gas output modifier). These should be set to the reciprocal of (1-.5* (desired reduction in capital stock)). The model inverts and multiplies by this factor in calculating these outputs, and the relationship of reduction in output for these sectors to reduction in capital stock was found to be .5:1.[2]

In the earlier version of the User's Guide, a set of prepared initial capital stock conditions was presented and provided with the model. Given the case of generating these conditions in the revised model, this is not necessary here. Further documentation on what an initial conditions archive and reasonable variants from it will appear in a separate report on the SEMREC3 Baseline Case Analysis.

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[1] DK_ _ _variables appear in the model for each producing sector and branch. If no capital stock reduction is desired in a sector, the analyst merely does not inlude the DK_ _ _in the archive which supercedes the models basic data archives.

[2] Default value for these multipliers is 1. See Base Case document for details on structuring exogenous data files for RXTGAN and RXTOIP. RXTOIP is different from one only for one year. RXTGAN should decline over the period to 1.

IV   TERMINAL USERS' GUIDE

A.   The TROLL System

The computer software system on which SOVMOD and SEMREC are simulated
is called TROLL (Time-shared Reactive On-Line Laboratory) and is provided
by the Information Processing Service of the Massachusetts Institute of
Technology. TROLL was developed at M.I.T. for the National Bureau of
Economic Research and is a tool specially designed for econometric re-
search, model building, and testing. It has proved particularly cost-
effective for SEMREC work. The software system is interactive, i.e.,
executes a command, then asks for further information from the user or
informs him of errors encountered and possible corrective action to be
taken.

Information is inputted to and outputted from TROLL via a file system.
The following are the types of files used by TROLL:

- Data -- cross-section or time series, subdivided into users'
  files, archives, and individual data names

- Model -- equations and variable declarations (exogenous, en-
  dogenous, definition, coefficient, and parameter)

- Coefficient -- values for coefficients, one file associated
  with each model name.

- Dataset[1] -- Output Dataset: each file contains the output
  (solution values for each variable for the simu-
  lation period) of a particular model simulation.

  -- Input Dataset: values drawn from the data files
  for each exogenous variable (for the whole simu-
  lation period) and each endogenous variable (an
  initial period value only) required for a
  particular model simulation.

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[1] Datasets are usually created by TROLL during the simulation process
rather than being supplied by the user. Datasets can be transformed
into datafiles, and vice versa, with a TROLL command, however.

TROLL includes, as well, a large number of commands which process the information provided to the file system by the user. Certain of these, called high-level commands, may be given at any time during a TROLL session. Low-level commands represent sub-sets associated with various high-level commands and can be used only after an appropriate high-level command is given.

Some of the more important high-level commands in TROLL include:

- SIMULATE — initiates the process of model simulation; further information will be required from the user

- REG — initiates regression (or one or a series of equations)

- CEDIT — calls an entire coefficient file associated with one model—low-level commands are then used to operate on the information stored there

- MODEDIT — calls a particular model from the files to be edited via low-level commands

Commands are given by the user following a prompt by TROLL. It is appropriate to give a high-level command at any point during a TROLL session. When TROLL is asking for a high-level command, specifically, the prompt given is:

TROLL COMMAND.

Low-level commands, however, may be given only after the appropriate high-level command is given[1]. The prompt by TROLL for the low-level command is specific to the sub-set in question. Thus an illustrative sequence might be:

TROLL COMMAND.	CEDIT SEMREC:
CEDIT COMMAND.	DELETE C100;
CEDIT COMMAND.	FILE;
TROLL COMMAND.	---

---

[1] The exception relates to modedit commands. If during the TROLL session, the high-level command USEMOD followed by a model name is given, any of the set of modedit low-level commands can be used and will automatically refer to that model.

The above sequence deletes the coefficient C100 and its value from the co-efficient file associated with the model named SEMREC. The FILE command permanently stores this change, terminates the CEDIT process, and tells the system to prepare for another high-level command.

The commands of primary interest to the analyst who wishes to run SEMREC simulations perform the following tasks:

- Select data archives and files to be used by TROLL in creating the input dataset for a model simulation

- Set analyst levers to represent the assumptions desired for the particular simulation. This may involve simply setting exogenous values or may also require altering the model specifications

- Set bounds for the simulation period and initiate the simulation

- Display results of the simulation; compare output with that of previous model runs.

The use of the appropriate commands for these tasks will be detailed in the sections below. It should be noted that through TROLL'S MACRO facility it is possible for the user to write canned programs which can reduce frequently used sets of Troll commands to one macro command. For 'instance, the single command:

<div align="center">&SRCHREC3</div>

calls a macro (a subprogram) which is stored in the user's files which sets up the appropriate data archives in the proper sequence to simulate the model without any reduction in capital stock or population. This re-places a series of about eight separate commands, which might easily be entered with errors. The detailed individual commands will be provided here along with the macro shortcuts where appropriate. The details of building macro programs are provided in monographs available from MIT IPS.

B.   Data Management

1.   Data Manipulation for SEMREC RUNS

Data records for the TROLL user may be grouped into data archives
in the user's files. If no archive name is provided, the data file is
stored in the user's working space. The archive name is specified as a
prefix to the file name, e.g.,

USSR_KIMB[1]

In this case, the data file for the variable KIMB (capital stock of the
MBMW branch is stored in the archive named USSR. The particular data file
may be stored in more than one archive, and the values given do not have
to agree. This is particularly useful for storing alternative sets of
initial conditions. Thus, capital stock reduction data can be stored
in a series of archives:

MISC_DKIMB
BASE10_DKIMB
BASE25_DKIMB

In an individual simulation, TROLL can be directed to look for values
for the variables in particular archives when creating the input dataset
for the simulation. This is done by specifying a search list. Troll looks
at the archives in the order specified in the search list and finding a
data file, looks no further for data for that variable (i.e., in archives
later in the search list.) A search list remains in effect throughout a
Troll session unless it is altered by the user. The search list is speci-
fied by use of the SEARCH commands which include SEARCH FIRST, SEARCH LAST,

---

[1] The use of the underscore to link the archive and data names is
specific to the terminal used (TI Silent 700 Series). Others may
substitute another symbol.

SEARCH AFTER, and SEARCH BEFORE. Only archive names need to be given to cover all data files in those archives, e.g.,

TROLL COMMAND. SEARCH FIRST DATA _ USSR DATA _ SEMREC; to check the search list, give the command:

TROLL COMMAND. LKSEARCH DATA:[1]

Troll responds with the archives in the order the user has specified:

DATA _ USSR
DATA _ SEMREC
USER (W)

This last entry is the user's working space where all unarchived data is filed. It is included in the search list automatically as the last entry. If the command

TROLL COMMAND. SEARCH FIRST DATA _ NCD:

is now given, the LKSEARCH DATA command will elicit:

DATA_NCD
DATA_USSR
DATA_SEMREC
USER (W)

The command DELSEARCH DATA _ USSR deletes the archive USSR from the search list. It is useful here to examine a concrete example of the use of the

---

[1] This command may be entered by the user at any time during the TROLL mission.

search list to introduce initial conditions into a simulation, where those conditions differ from historical data.

Excluding a case which contains no damage to either capital stock or population, initial conditions must be introduced that encompass values for reduction of capital stock lagged one period before the recovery is to begin and population variables (these are exogenous and a value must be supplied for each year of the simulation. This is accomplished by building a data archive with these variables and placing it first in the SEARCH list, superceding default values.

Historical data and exogenous values projected through the simulation period (forward data) which are shared by the peacetime model and SEMREC are filed in the archive named USSR. Variables specific to SEMREC are filed in the archive SEMREC. Reduced forward data for population are stored in the archives named CD, CD24, and NCD with 16%, 24%, and 31% reduction in population respectively. Now we wish to build a data file for DKIMB (percent reduction in capital stock in the MBMW branch) alter the data file for the 1975 entry (the year preceding the start of recovery) and file it in an archive representing initial conditions of a pre-determined reduction in industrial capital stock.

First we call up the default data:

TROLL COMMAND. DEDIT MISC _ DKIMB

We desire a hypothetical figure of 40% reduction.

DEDIT COMMAND. REPLACE 1975 .40

and now place new series (identical but for 1975 entry) in the BASEK archive:

DEDIT COMMAND. FILE BASEK _ DKIMB

TROLL COMMAND. DEDIT . . .

This procedure is repeated for each of the capital stock, reduction involved in introducing the initial conditions into the simulation. The search list is then specified:

    TROLL COMMAND. &SRCHREC3

    TROLL COMMAND. SEARCH FIRST DATA _ NCD DATA _ BASEK

and checked:

    TROLL COMMAND. LKSEARCH DATA:

with the response:

    DATA _ NCD
    DATA _ BASEK
    DATA _ and so on determined by &SRCHREC3

When the input dataset is created by the simulate command, TROLL finds the population variables in NCD (even though a non-reduced series exists in USSR), most of the capital stock reduction parameters in BASEK and the rest of the variables have data drawn from MISC and USSR and other basic data archives searched by executing &SRCHREC3.

In this manner packages of initial conditions can be saved in the files, easily incorporated and replaced for simulation, and actual historical values need never be altered and remain for reference purposes and baseline runs. Through the use of the MACRO facility on TROLL, single commands can be created to assemble search lists for a series of scenarios incorporating combinations of initial conditions. The search list is automatically printed for the user, e.g., &SRCHBASE which is an initial set of assumptions for a baseline case and has been supplied with SEMREC3.

Analyst levers stored as exogenous data can be manipulated identically (see table following). If new data files for a lever do precede the archives in &SRCHREC3, the default values are used in the simulation. If you are not certain of where a data file appears, after executing a search list give the command:

TROLL COMMAND: PRTDATA DKIMB;

and the system responds with each occurrence of this data file in a archive.

Table IV-1

Analyst Levers Stored as Exogenous Data
For guidance in setting these levers see SEMREC3A: Baseline Soviet Recovery Case,
CEPR-TN-8156-2.
A.   FOREIGN TRADE

1.   ANALYST ADJUSTED DATA

MU1 through MU25 - lever applied to peace-time portion of
                    equation
KAPPA1 through KAPPA25 - lever applied to recovery portion of
                    equation
PSI1 through PSI25 - annual unexplained increase/decrease to
                    foreign trade flows
RHO1 through RHO25 - growth rate of trade flows
TAU1 through TAU25 - y intercept

2.   USE OF VARIABLES:

a.   MU1 through MU25 and KAPPA1 through KAPPA25

In the pre-attack periods all MU variables should
equal 1, and all KAPPA variables should equal 0.
In the recovery period, MUS typically are set to
0, KAPPA <1. (Note all KAPPAS=0 for trade with
the developed West will cause an error, moreover
not a likely assumption).

b.   PSI1 through PSI25

All PSI values should equal 0 at all times UNLESS
the analyst desires to annually increase or
decrease specific trade flows exogenously. All
PSI variables are time vectors and therefore a
"one-time shot in the arm" increase or decrease is
supplied to the system by changing PSI for one
year only from 0 to a new analyst-determined
value.

c.   RHO1 through RHO25

All RHO variables were regression generated.
Increasing or decreasing RHO values will increase
or decrease growth of a specific foreign trade
variable away from historical trends.

d.   TAU1 through TAU25

All TAU variables were regression generated. They
should not be changed by the analyst, as they
represent the y intercept.

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B. CONSUMPTION

1. ANALYST ADJUSTED DATA FILES:

NPOP9 - total population

GAMMAD - target ratio of post-attack per capita durables
                  consumption to 1975 level
GAMMAND - target ratio of post-attack per capita non-durables
                  consumption to 1975 level
GAMMAS - target ratio of post-attack per capita services
                  consumption to 1975 level
GAMMAF - target ratio of post-attack per capita food
                  consumption to 1975 level

BETAD - historical growth rate of per capita durables
                  consumption
BETAND - historical growth rate of per capita non-durables
                  consumption
BETAS - historical growth rate of per capita services
                  consumption
BETAF - historical growth rate of per capita food consumption

2. USE OF VARIABLES:

a. NPOP9

Total population estimates used to represent varying
degrees of civil defense automatically fall into place
in all of the consumption functions.

b. GAMMA$_{xx}$

All of the GAMMA variables should be set equal to 1
during the peace-time period. In the recovery period,
all should be set equal to some value less than or
equal to 1 for each year. Typically all may be set
equal to .8 during the recovery period with the
exception of GAMMAD which is reduced to .1 to reflect a
dramatic decrease in consumer durables consumption.

c. BETA$_{xx}$

All of the BETA variables were regression generated.
Increasing or decreasing any BETA value will increase
or decrease the growth of a specific consumption
variable relative to historical trends. (Note: small
changes cause rather large shifts (i.e., a 10% decrease
in the size of a Beta will be rather significant).

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C. INVESTMENT

1. ANALYST ADJUSTED DATA FILES:

DELTAINA - unexplained multiplier (non-ag investment)
DELTAIAM -   "   "   (machinery component, ag
                                        investment)
DELTAIAC -   "   "   (construction component, ag
                                        investment)

ZETAINA - average annual growth rate of non-ag investment
ZETAIAM -   "   "   "   "   machinery comp., ag
                                              investment
ZETAIAC -   "   "   "   "   construction component of
                                              ag. investment

ETAINA - target figure, non-ag investment
ETAIAM -   "   "   machinery component, ag investment
ETAIAC -   "   "   construction component, ag investment

2. USE OF VARIABLES:

a. DELTA$_{xxx}$

All DELTA variables represent unexplained boosts to
investment. Because of the form of the equations within
which they appear, such boosts must be entered IN LOG FORM.
Therefore, if non-ag investment for a given year is to be
doubled, DELTAINA for that particular year must be stored in
an archive as the natural log of 2.

b. ZETA$_{xxx}$

All ZETA variables were regression generated. Increasing or
decreasing ZETA values will increase or decrease the growth
of a specific investment variable vis-a-vis the historical
trend.

c. ETA$_{xxx}$

All ETA variables were regression generated. They represent
the base from which specific investment variables grow. It
is important that during the recovery period investment
levels decrease (as do levels of capital stock and capital
formation), and this is precisely what happens in the
equations which normalize on the ETA variables. It is
assumed that the decrease in investment will equal the
decrease to machine building capital stock in general,
DKIMB.

2   TROLL Commands for Data Manipulation

DEDIT is TROLL shorthand for "data edit". Since data are stored
in the user's library and therefore are not specific to any particular
model (unless expressly indicated by the analyst), data may be edited with
or without the use of a USEMOD command. The most commonly used DEDIT
commands are listed below. The analyst should pay close attention to the
FILE command and also to the DEDIT command which must be used before data
can be altered in any fashion.

DEDIT - This command not only prepares the TROLL system
for all of the low-level DEDIT commands, it also
is used to specify the particular data file to be
edited whether it is an existing data file or not.
For example, the following is correct:

DEDIT MIECH:

Where MIECH is the name of a data file.

Only one variable name may follow DEDIT since the
analyst is allowed to manipulate only one data file
at a time. The DEDIT command listed above auto-
matically elicits the following--if a file named
MIECH already exists:

DEDIT COMMAND:

If a data file named MIECH does not already exist,
the TROLL system responds with:

NEW SERIES, MIECH:

and asks for needed information including periodicity
and a start date. If the analyst desires to add data
into this new data file he must then proceed to an
ADD command.

If a variable appears in more than one archive, the
archive named must be included in the DEDIT command:

DEDIT SEMREC_MIECH:

ADD –   used to enter data into data files. The following
            are all proper forms of the ADD command:

            ADD 1950, 1.234;
            ADD TOP, 1.234 5.678;

            where 1950 and TOP indicate the desired location of
            the new data. All data in data files is associated
            with individual years. TROLL does not require the
            analyst to input each year one at a time because it
            assumes data will be entered in chronological order
            with a known start date as determined in the DEDIT
            command. Assuming annual data is being used as is
            the case with all data associated with SEMREC1, the
            first ADD command listed above will insert the value
            1.234 after the value that appears for 1950. In
            other words:

            1951 = 1.234

            Furthermore, all values already in the data file
            after 1950 will be adjusted forward by one year.
            The second ADD command adds two values beginning
            with the first year listed in the data file and
            will adjust forward all values in the file by
            two years. If the analyst needs to change a value
            (or several values) within a data file and not
            adjust any other values, the REPLACE command
            should be used.

COMMENT –   used to write comments associated with individual
            data files. Semi-colons may not be used at any time
            within the comment, but all comments are concluded
            with one. For example, the following is correct:

            COMMENT GROSS NATIONAL PRODUCT, EXPENDITURES SIDE,
                    CURRENT DOLLARS:

DELETE –   this command is used to delete values specified within
            a data file. It does not remove the year or years
            associated with those values and therefore all values
            that followed the deleted values are moved "backwards
            in time" so that no gaps exist. The following are
            correct:

            DELETE 1958;
            DELETE 1964 to 1970;
            DELETE TOP to 1975;

FILE – used to permanently store all data changes made by the analyst. Data should be filed using both the archive name and the variable name as shown in the following examples:

FILE BASE40_KISG:
FILE SE<REC_MTM1209;

If no archive name is given, the data is automatically stored in the current (working) file.

PRINT – used to examine data files or any portion of a data file. The following PRINT commands are correct, when in DEDIT mode:

PRINT DATA:--prints all data within the data file.
PRINT ALL:--prints the entire data file, data and comments.
PRINT 1956;--prints the value corresponding to 1956.
PRINT 1965 to 1971--prints values from 1965 to 1971.

REPLACE – as noted earlier, this command is used to change a value associated with a given year while not affecting any other data in the data file. For example:

REPLACE 1963 15.1;
REPLACE 1970 11.17 12.80 15.77;--this command replaces old values for 1970, 1971, and 1972 with values specified in the command.

C.   Altering Key Parameters and Equations

1.   Techniques for Model Modification

Aside from the data question, the other major aspects of the
model simulation are the coefficients (parameters), the symbol declarations
and the model equations. For most simulations these components will be
unchanged from the basic formulation provided to the user. There are,
however, important variations.

In most SEMREC equations the coefficients on variables are
entered with a symbol rather than a numerical value. The numerical values
are stored in the coefficient file associated with the SEMREC model. This
is a useful approach because many of the coefficients are shared by SEMREC
and SOVMOD. The SEMREC coefficient file, however, contains some important
additions--for example, the labor force participation rate (NPART9).

These are key analyst levers and the user may wish to change them
from their basic values either to one new value for the simulation period
or varying them during the period. In the first case, only editing of the
coefficient file is required. The user should remember that when the
simulation is completed the basic values should be restored. Any editing
which is done on the coefficient would carry over to the next session. An
example is given here of editing the coefficient file to increase the
balancing priority of the MBMW sector, throughout the simulation period,
from a value of 1 to 2. The following is a sequence of commands and
TROLL's responses.

---

[1]   Also the share of collective form (SKOL9) and state form (SSOV9)
employment in total agricultural/employment-set to 1975 actual values.

```
TROLL COMMAND.   CEDIT SEMREC3A;

CEDIT COMMAND.   PRINT A06;

    A06          1.

CEDIT COMMAND.   REPLACE A06   2.;

CEDIT COMMAND.   PRINT A06;

    A06          2.

CEDIT COMMAND.   FILE;
```

On the other hand, the user may wish to increase the value of PLMB9 to 2 only for the first five years of the simulation period. It is then necessary to change the declaration of the symbol from COEFFICIENT to EXOGENOUS. This requires a series of MODEDIT commands. The PLMB9 entry may remain in the coefficient file without effect. When editing the model, the editing is not saved from session to session unless the command FILEMOD is given. If the user does not wish to save the editing, giving the command

```
        TROLL COMMAND.   USEMOD SEMREC3A;
```

restores the model to the form it had at the time the last FILEMOD command was given. This will also occur if the current TROLL session is terminated without filing the model. The following is the sequence of TROLL commands and responses which convert NPART9 from a coefficient to an exogenous variable and create a data file. Note that every . is a prompt for information from the user.

```
        TROLL COMMAND.     USEMOD SEMREC3A;

        TROLL COMMAND.     CHANGESYM EXOGENOUS NPART9;

        MODEDIT COMMAND.   FILEMOD;

        TROLL COMMAND.     DEDIT NPART9;
```

```
            NEW SERIES NPART9

        ENTER PERIODICITY. 1 (i.e., annual data)

        ENTER STARTDATE.  1973 (i.e., first year of simulation)

        DEDIT COMMAND.  ADD TOP .92.92.92.92.92.92.92.92.92.92.92.92;

        DEDIT COMMAND.    PRINT DATA,

          NPART9

            DATA

            1973          .92 .92 .92 .92

            1977          .92 .92 .92 .92

            1981          .92 .92 .92 .92

        DEDIT COMMAND.    FILE;
```

This set of commands has created a data file for the variable PLMB9 and
filed it in the user's working space (no archive was specified with the
last FILE command). Because PLMB9 is to be an exogenous variable, a value
is required for every year of the simulation period.

The symbol NPART9 already occurred in the basic model, but was
declared to be a coefficient (i.e., has the same value in any period). The
model had to be edited to change the declaration. To return the model to
its previous specification, the anlayst must enter:

```
        TROLL COMMAND.    CHANGESYM COEFFICIENT NPART9;


        MODEDIT COMMAND.  FILEMOD;
```

Note that the first change was permanently filed and can only be reversed
by new model editing given above. The value for the coefficient NPART9 had
remained in the SEMREC3A coefficient file.

To change priority weights for balancing, CEDIT is used, as in the
example. The adjustment weights are coefficients A01 through A40. See
Appendix I for correspondence of numbered A weight and adjustment variable.

Analyst Levers Stored as Coefficients

A. LABOR ALLOCATION

1. SELECTED ANALYST ADJUSTED DATA COEFFIEICNTS:

RNKS9 — labor/capital ratio for 1975 (represents level of technology

RNKG9 — " "   "   "   "   "   "

RNKEP9 — " "   "   "   "   "   "

RNKPP9 — " "   "   "   "   "   "

RNKSG9 — " "   "   "   "   "   "

RNKF9 — " "   "   "   "   "   "

RNKO9 — " "   "   "   "   "   "

RNKNC9 — " "   "   "   "   "   "

2. USE OF VARIABLES

    a. $RNK_{xx}9$

       Labor/capital ratios used in the model are representative of
       those for 1975. They illustrate a level of technology
       specific to that year. If the analyst desires to alter the
       ratio, he must first determine the level of technology
       planned to exist in the post-attack period, and substitute
       appropriate values for the labor/capital variables.

    b. NTNEC

       Do not adjust this variable, it is endogenous.

    c. NTOTAL

       This variable is automatically adjusted when initial levels
       of population and therefore able-bodied population are
       introduced into the system. NPART9, the ecogenously
       supplied participation rate may be adjusted by the analyst,
       but it should be noted that it is already quite high.

2   Editing Equations, Altering Coefficients and Changing
    Symbol Declarations

Following are detailed descriptions of TROLL commands frequently
used in altering key parameters and model specifications before simulation.

Before using any MODEDIT command, a USEMOD command, identifying
the model to be used, must be entered[1], after which any of the following
MODEDIT commands are acceptable:

ADDEQ – used to add equations to the model called for in
the USEMOD command. When properly used, it is
written:

ADDEQ 10,

where 10 refers to the number of the equation after
which you want to add a new equation. Therefore,
ADDEQ 10 will insert a new equation into position
number 11 and will push all equations that used to
follow equation number 10 so that they now follow the
newly added equation, equation number 11. Note that
this command is followed by a comma, not a semi-
colon. The system automatically responds with:

EQUATION:

at which point the user enters the equation without
any blank spaces--push it all together. When the
equation has been entered, enter a semi-colon.

ADDSYM – used to add new variable names into the model. All
variables must be entered as one of the following
variable types:

                coefficient;
                definition;
                endogenous;
                exogenous; or
                parameter.

---

[1] The USEMOD command need be entered only once, and will hold throughout
the TROLL session unless another USEMOD command with another model
name is entered.

If the analyst enters an equation and does not declare the variables within that equation to be one of the five variable types listed above, the TROLL system automatically assumes all of them to be exogenous. If this happens, the CHANGESYM command must be used to change the variable type. When properly used, the ADDSYM command appears as follows:

ADDSYM COEFFICIENT C123;

The command written immediately above enters the variable, C123 into the model, as a coefficient. If C123 had already been used in the model, the system would automatically generate an error message indicating such, and the analyst must either rename the variable or use the CHANGESYM command.

CHANGEQ — used to alter equations already in the model. When properly used, the CHANGEQ command appears as follows:

CHANGEQ OFFN ONF $error$alteration$ G ALL;

Where OFFN suppresses the automatic system response of telling the analyst which equations were not altered as a result of this command. ONF activates the system to notify the analyst of all equations where changes were made. Surrounded by dollar signs number 1 and 2 above is a portion of an equation that is to be changed. The system will scan all equations looking for that string. It will replace everything within those dollar signs with what ever lies between dollar signs number 2 and 3. The letter G (for general) tells the system to make such changes everytime it finds the error within each equation. Without this letter G, a change will be made only the first time it is discovered within each equation. ALL tells the system to look for the error in every equation. In place of ALL, the analyst may substitute an equation number or several equation numbers—each separated by a blank space.

CHANGESYM — used to change the variable declaration type of variables already entered and declared in the model. When properly used, it appears as follows:

CHANGESYM DEFINITION XOIN;

Where DEFINITION is the new variable type desired and XOIN is the variable in question. More than one variable may be listed, provided that they are separated by spaces.

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DELEQ - used to delete equations already in the model. This command erases the equation in question and auto- matically renumbers all equations that follow it in the model. It does not remove the variable names used by the equation from the lists of variable types. This must be done separately by the analyst using the DELSYM command. When properly used, the DELEQ command appears as follows:

DELEQ 16;

Where 16 refers to the number of the equation to be deleted. More than one equation number may be listed, provided that all numbers are separated by spaces.

DELSYM - used to remove variable names, regardless of variable type from the lists of variable names. Only variables that do not appear within the body of the model may be removed. Therefore, an analyst may need to use DELEQ first.

The proper forms of this command are,

DELSYM KIMB;

DELSYM KIMB KIEP A.KITOT;

FILEMOD - used to permanently store a revised model. If the command is entered:

FILEMOD;

the model will be filed under the name given in the USEMOD command as noted earlier. If the analyst de- sires this revised model to be stored under a new name (SEMREC2, for example), the command should be,

FILEMOD SEMREC2;

PRINT or PRTMOD - used to print, on a terminal, any portion of a model. PRINT is only used when the system is asking for a MODEDIT COMMAND. All of the following are proper commands:

> PRIMOD EQ 20; also PRINT
> PRTMOD EQ TOP TO BOTTOM; also PRINT
> PRTMOD SYM ALL; also PRINT
> PRTMOD SYM ENDOGENOUS PARAMETER;
>   also PRINT

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1.0

1.1

1.25

2.8 2.5

3.2 2.2

3.6

4.0 2.0

1.8

1.4 1.6

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A
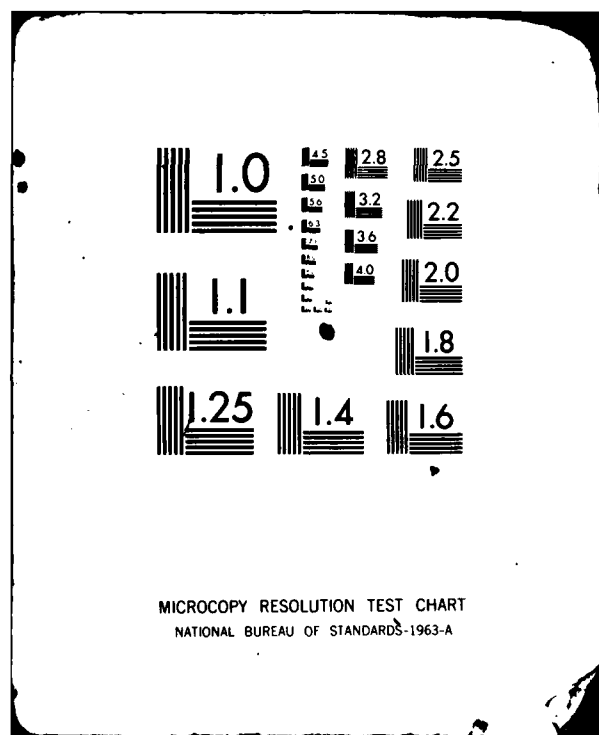
CEDIT commands are used to alter and examine the coefficient file[1] that contains names and values for all constants and parameters used by the model. The coefficient file is named after the model and no USEMOD command needs to be entered before using the CEDIT commands. However, the following command must precede any of the low-level CEDIT commands:

CEDIT SEMREC3;

after which the TROLL system will respond with:

CEDIT COMMAND:.

The following are the most commonly used CEDIT commands:

ADD – inserts new constants and/or parameters into the coefficient file. The following is proper:

ADD C1202 14.178;

The above command enters a constant or parameter named C1202 into the constant file whose value is 14.178.

DELETE – removes both a constant or parameter already named within the coefficient file and the value associated with it. The value of the constant or parameter need not be stated in the DELETE command—it is automatically deleted. The following are correct:

DELETE C118;
DELETE C257 ALT1;

PRINT – used to examine constants or parameters located in the coefficient file. The following are correct:

PRINT ALT8;
PRINT C1107 C1201 ALT10;

REPLACE – used to replace a value associated with a constant or parameter already located within the coefficient file. The following are correct:

REPLACE C854 16.2;
REPLACE C201 6;

---

[1] also known as the constant file

D.   Running A Model Simulation

   1.   Initiating and Executing a Simulation

      If the model specifications and symbol declarations are set
properly for the desired simulation and a search list is specified to in-
troduce the initial conditions, the user is ready to simulate. . Two steps
should be taken, however, to insure the appropriate input dataset will
be created for the simulation. The command should be given:

         TROLL COMMAND.   DELETE DSET SEMREC3;

The input DSET is always given the name of the model by TROLL. If such a
DSET is already stored in the files, it will be used by TROLL in simu-
lation, even if it has been created using a different search list. If it
is not deleted and the model has been edited, the simulation command will
produce the error message that the DSET does not correspond to the model.
If there has been no editing, the model may simulate using the wrong data.
If the DSET had already been deleted by troll, the delete command above
will elicit the warning:

         FILE(S) NOT FOUND-

            DSET SEMREC3

The warning can be ignored (it is not an error) and the user can proceed.
If the DSET was found and deleted, the terminal will merely prompt for
another TROLL COMMAND. The user should also check the search list before
simulating to be certain it is correct. This is done by giving the command:

         TROLL COMMAND.   LKSEARCH DATA:

TROLL responds with the search list in effect.

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To initiate the simulation of the model (specified in a USEMOD SEMREC2 command previously given, the user enters the command:

TROLL COMMAND.   SIMULATE;

The troll system incorporates a number of options associated with the simulate command, but these are primarily useful in testing a new model and will not be covered here.   The command simulate triggers a series of actions by TROLL that prepares for, but does not start the simulation process.   Troll creates the input dataset, analyzes the model to normalize each equation on an endogenous variable or definition and forms a block structure[1], and creates the code by which the model is simulated.   This is a time-consuming process and the system may print blips (usually a '%') to indicate that it is still working though no prompts have been printed. If the model has not been edited since the last simulation and the code was saved via a FILEMOD command, the same normalization, block structure, and code are used, so that only the DSET is created.   The following is a typical sequence of commands and responses:

TROLL COMMAND.   SIMULATE;

CREATING DSET SEMREC3A

%%% ANALYZING MODEL

%%%% GENERATING CODE TO SAVE CODE TYPE FILEMOD;

% SIMULATIONS CAN BEGIN FROM 1973 TO 1976 AND MUST END BY 1985

SIMULATE COMMAND. FILEMOD;

---

[1] This block structure is not the same as the conceptual breakdown into investment block, production, etc., but rather is used by TROLL for the simulation process and groups equations into sets of simultaneous equation blocks in the order they are solved.

The instructions from TROLL on the bounds of the simulation period are based on the data supplied. Exogenous values are required for every year of the simulation and a starting value is required for each endogenous variable. Thus, if endogenous variable data files were all extended beyond 1976, simulations could begin later. If exogenous variables were supplied prior to 1975 and beyond 1985, the permissible simulation bounds would be expanded.

At this point, the simulation can be executed. Three commands are required--to give a start date; to give an end date, and to file and name the output dataset. If no name is given to the output dataset it is called OUTPUT by TROLL and the next simulation will delete it and replace it with a new output DSET called OUTPUT. These commands are given as follows:

SIMULATE COMMAND. SIMSTART 1976;

SIMULATE COMMAND. DOTIL 1985; FILESIM SEMSIM;

TROLL COMMAND.

When the prompt TROLL COMMAND. is printed, the user knows the simulation has been successfully run.

2.   Obtaining Simulation Output

The output of a simulation is not printed until the user asks for it and specifies the format. The output of a single simulation may be displayed, or a number of output datasets displayed together for purposes of comparison. The command which displays the output is the PRTDSET command. The variables, range of periods, and output DSETS used must be specified with this command. The following command initiates the printing of all endogenous variables in the output dataset SEMSIM and SEMBASE for the period 1976 to 1985:

TROLL COMMAND. PRTDSET, VARIABLES ENDOGENOUS,

RANGE 1976 TO 1985, DSETS SEMSIM SEMBASE;

TROLL responds:

SIMULATION OUTPUT BY VARIABLE

ADLVR –	SEMSIM	SEM BASE
1976	----	----
1977	----	----

and so on. If the range is specified in the command first, TROLL responds:

SIMULATION OUTPUT BY YEAR

1976 –	SEMSIM	SEMBASE
ADLVR	----	----
AVCP70	----	----

If the DSETS are specified first, they are printed separately, the structure of the output depending on the order of the range and variables lists specifications. TROLL also permits the user to obtain graphic displays of simulation output with the PLTDSET command. Datasets that have been filed are saved from session to session. Output datasets should be given names descriptive of the particular simulation (e.g., SEMBASE) and periodically deleted when no longer needed to keep disk records available. The command is:

TROLL COMMAND. DELETE DSET SEMSIM;

Datasets can also be converted to datafiles. This would be useful, for instance, if the user needed data for a variable that is endogenous in SOVMOD and exogenous in SEMREC. The exogenous data for the SEMREC variable for 1976 to 1985 can be drawn from an output DSET of a SOVMOD simulation of that period. If the variable is BAO, the SOVMOD simulation in SOVI, then the command is:

TROLL COMMAND. CRDATA DSETS SOVI, RANGE 1976 TO 1985, VARIABLES BAO;

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The CRDATA command creates the data file and stores it in an archive with the name of the dataset it comes from, e.g., SOVI_ BAO.

3.   Commands Associated with Model Simulation

Simulations are initiated with the following high-level command:

SIMULATE;

at which time the system informs the user of progress it is making through the various stages of simulation. Eventually the system will respond with:

GENERATING DSET SEMREC3 - if the DSET SEMREC3 was
deleted, as noted earlier
ANALYSING MODEL - if the model has been edited
GENERATING CODE - if the model has been edited
SIMULATIONS CAN BEGIN FROM 1973 TO 1976 AND MUST END BY 1985
SIMULATE COMMAND: .

At this point TROLL wants to know three things:

1.   the year simulation is to begin;
2.   the year simulation is to end; and
3.   the desired name of the data set under which the
       simulation results are to be filed.

All of this is accomplished by entering the following on one line:

SIMSTART 1973; DOTIL 1985; FILESIM RELCONTR:

Where RELCONTR is the analyst desired name of the new DSET

after which the system will respond:

TROLL COMMAND: .

The results of a simulation are stored in a dataset named in the SIMULATE command listed above. To view this dataset or several data sets, enter the following:

        PRTDSET,   (This initiates the printing of data set(s)
                    procedure.)

After the system responds, enter:

        VARIABLES (Thereby telling the system you are about
                   to enter the names of the variables you
                   want to see. Note there is no comma.)

After the system responds, enter:

        GNP GNPNA XOIN XOMB KITOT, (Or whatever variables the analyst
                                   desires. Note that a comma
                                   ends the list.)

Then enter:

        RANGE 1976 TO 1985, (Or whatever the analyst wants to see)

This is followed by:

        DSETS (Again, no comma)

Finally enter:

        RELCONTR SEMBASE B1ONCD; (Or whatever data sets the
                              analyst desires. Note the
                              semi-colon.)

The system will respond by printing back the desired results.

E. Common Errors

In this section some errors most commonly encountered in using
SEMREC/SOVMOD on troll will be discussed. Along with the error message
an attempt will be made to indicate the cause and corrective action
indicated.

1. Frequent Errors Throughout A Session

ERROR MESSAGE

NOT A COMMAND   This message indicates that a command was
misspelled or that a low-level command was
given when a high-level command was required.
Retype the command and give the proper high-
level command first if appropriate.

FILE(S) NOT FOUND   A filename was misspelled, an archive name
was wrong or missing, or the search list is
misspecified. Retype the command and ex-
amine and correct the search list if necessary.

MODEL NOT FOUND   The USEMOD command was not given, or a
model name was not specified in a MODEDIT command.
Give a USEMOD command before retyping your
last command.

2. Frequent Errors in Editing Data, Coefficients or the Model
Error Message

NEW SERIES   This is a warning from troll, not necessarily
an error. If the user intended to edit an
existing series, then he has misspelled the
name or failed to give the proper archive
name. Retype.

NEW MODEL   This is a warning from troll, not necessarily
an error. If the user intended to edit an
existing model, he has misspelled the name
of the model or has stored the model in the
working space of another user. If the model
is stored elsewhere, enter the appropriate
ACCESS and SEARCH commands.

DATA GIVEN DOES NOT FALL WITHIN CURRENT BOUNDS FOR THE SERIES	This error is likely to occur while entering any of the DEDIT commands. It indicates that the user has attempted to manipulate data in an already existing data file for years not contained within the file. Retype the DEDIT command with appropriate years, or expand the data file to include the desired years.
NOT A CHANGEABLE TYPE	This error is likely to occur after the analyst has entered either a MODEDIT or DEDIT command. It is usually the result of a typographical error and the command should be retyped and entered.
SYMBOL CANNOT BE DELETED	This error occurs after the DELSYM command has been entered. The TROLL system as a built-in safeguard will not permit the user to delete variable names from the list of variables associated with a given model if the symbol in question appears anywhere within that model. If the symbol must be deleted, the analyst must first delete all equations that contain the symbol, then enter the DELSYM command.
INVALID CONSTANT NAME	This error occurs while manipulating a constant file and is probably the result of a typographical error. Constant names must begin with a letter and may contain only letters, periods, and numbers. Further, constant names may be only eight characters long. Either rename the constant or correct and re-enter the command.

3. Frequent Errors in Simulation

ERROR MESSAGE

NOT ENOUGH STORAGE	While analyzing the model for simulation purposes, the TROLL system determines the amount of storage capacity required. To correct this, the analyst must expand his storage (automatically given by default). The error message will state how much storage is required for simulation, but increasing the amount by 25% is recommended.

JACOBIAN MATRIX IS POORLY SCALED OR NEARLY SINGULAR	This error may be the result of a scale problem, but is generated when the ratio of the largest pivot of the Jacobian matrix to the smallest pivot is greater than 10^8. To correct this problem enter: CONOPT MAXRAT 1E14;
RANGE FOR VARI- ABLES IS DISJOINT FROM OTHERS AFTER LAGS HAVE BEEN TAKEN INTO ACCOUNT	Even though the analyst has supplied data for all indogenous and exogenous variables, lags within the model may require additional information from the analyst. The variable in question will automatically be printed on the terminal at the conclusion of the error message. The problem can be solved usually by expanding the data file in question through the use of the DEDIT commands, but may also be overcome by al- tering the search list thereby using data from other archives.
ITERATION LIMIT EXCEEDED IN YEAR __ ITERATION __.	The default limit for iterations in the TROLL system is 10. This error may be the result of data problems or a model im- properly specified by the analyst. The problem can be solved by altering the con- vergence criterion (CONOPT CONCR .01;) or by adjusting upwards the maximum number of iterations allowed (CONOPT STOP 25;).
DIVERGENCE OCCURRED IN ITERATION __ YEAR __.	This problem may be the result of poor exogenous data or a poorly specified model. Careful attention should be given to assumptions embodied in the exogenous data. If problems are discovered in the data they may be corrected through the use of DEDIT commands. Problems discovered within the model may be corrected through the use of the MODEDIT commands. The divergence criterion can be altered by entering CONOPT DIVCR 25;. Finally the analyst may "correct" this problem instructing the system to begin testing the model after the iteration in question. This can be done by entering CONOPT START 5; (indicating tests for di- vergence should begin at iteration number 5.
DATA FILES MISSING	The first phase in simulation involves the generation of an input data set containing historical values for all endogenous variables. Lagged values for all variables

are also included. This error indicates that data cannot be located for one or more variables. The problem may be corrected by altering the search list, or by creating new data files for the variables in question.

DSET DOES NOT CORRESPOND TO MODEL	This error is the result of altering the model _in any fashion_ and beginning simulations without previously deleting the input data set. The problem can be corrected by entering DELETE DSET SEMREC; and then beginning the model simulation.
ATTEMPT TO TAKE LOG OF A NON-POSITIVE NUMBER	This problem may be the result of poor data, scale problems or errors within equations, the command LIST ITER < variable name or names >; and begin the simulation process again. This command will cause the TROLL system to print iteration values of suspect variables. This may lead to altering exogenous data or careful attention paid to model specifications.
DEFINITION OR CONSTRUCT USED BEFORE IT IS DEFINED	During simulation, the TROLL system breaks the model into numerous blocks, solving block 1 first and then proceeding to block 2 and so on. This error appears if a variable declared to be a definition appears within a block prior to the block that contains the equation defining the variable a question. The problem can be corrected by putting all equations written as definitions at the beginning of the model.
MODEL HAS FEWER (MORE) ENDOGENOUS VARIABLES THAN EQUATIONS	The number of equations written as definitions must equal the number of variables declared to be definitions. The number of equations written otherwise must equal the number of variables declared to be endogenous. To correct this problem the variables list must be printed and all endogenous variables and definitions must be manually checked with individual equations. It is not possible, with large models to visually scan the equations and identify the variables on which the TROLL system is normalizing. The command LKORD; will cause the TROLL system to print each equation by number and the normalized variable associated with it. Such a listing will help the analyst to determine the problem variable (variables) or equation (equations).

F.   A Recap on Running the Model

1.   Initial Conditions

In SEMREC3A, the procedure for generating a set of initial conditions
for capital stock to run a scenario is greatly simplified from the point of
view of the analyst. He no longer has to worry about calculating the
capital stocks for the initial recovery year or providing reduced
investment flows given exogenously from peacetime.

The analyst needs to provide the model only with percentage reductions
in branch and sector capital stocks. These are represented in the model as
exogenous variables (DK   ; the variable K   is the capital stock
affected. Note that capital stock for the current year is endogenous. It
is calculated by adding capital formation last year to the initial capital
stock last year. Therefore, if reduction in capital stock is to occur one
time only (it becomes a permanent reduction, i.e., growth in capital stock
is achieved only via succeeding capital formation), the   DK   variable
is set to the ratio of capital removed to total for the year before the
reduction is to take place. That is, if the capital stock of the soft
goods branch is to be reduced by 5 percent in 1976 (for purposes of example
only), then DKISG should be set to .05 for 1975 and set to zero for every
other year. The model automatically calculates the new capital stock by
reducing the net value of the 1975 capital stock carried over to 1976 and
reduces capital formation and investment flows appropriately as well.
Thus, in periods later than 1976 capital formation depends on lagged
investment which predates 1976, those investment flows will be reduced by
the same percentage as the capital stock in the branch or sector. Some
capital formation equations contain investment lagged five periods.

Population initial conditions can be reset by generating a new
population data archive and placing it on the SEARCH list prior to existing
population archives. Data are required for total population (NPOP9) and
able-bodied population (NPOPAB9). These are both exogenous variables and a
value for each year of the simulation must be supplied. Several
alternative population archives are available with the model.

2. Setting Analyst Levers

There are two types of analyst levers that must be set for a model simulation. The first type is priority weights. They implicity enter the cost function for the balancing mechanism and explicitly appear in the adjustment equations. The higher the weight on an adjusted variable, the more likely the mechanism will find a solution which minimizes the change in that variable from the initial value. Both of these sets of priority weights are treated as coefficients by the model; there is one value stored for each that applies to every period and thus they are altered by a CEDIT command prior to simulation (it is not necessary to have a new input DSET created for simulation as is required after MODEDIT commands). The adjustment weights are normally set to 1.0 for all adjustments. This sets priorities on all outputs and end-uses to be equal. Note that weights are important in a relative sense, i.e., with one weight set at 2.0, an output adjustment in one sector would be twice as "costly" as an adjustment in any other sector in achieving balance. Changes in the weights would be made interactively in running a scenario. That is, if a model simulation shows too great an adjustment in an output or end-use that was required to achieve balance, then, in the next simulation, that sector's adjustment weight should be increased (possibly doubled as a first guess). It is likely that as a weight is increased successively, changes in the simulated adjusted value will be smaller with each simulation until no solution can be found. A real bottleneck will be indicated at that point, and changes in targets for other variables would be required to reduce the adjustment needed to obtain balance. On the whole, these sorts of calibrations are not required for moderate variants from the basic scenario and should only be undertaken after the analyst has a good feel for how the model behaves.

The other types of analyst lever affects the target functions in the model, that is, how initial values supplied to the balancing system are set. These levers are stored as exogenous data variables. When the model is run in peacetime mode, the functions reproduce historical values over

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the pre-recovery period for consumption, investment, and foreign trade.
For the recovery period, the analyst selects values for exogenous variables
in the equations which modify the setting of targets for end-uses (the
P. _ _ _):

    o   Consumption - the anlayst determines the share of per
           capita consumption on each category in 1975 to be
           maintained in the recovery period, e.g., GAMMA; a
           growth rate is built into each equation (e.g., BETAD,
           the historical rate of growth is the default value) to
           move the targets over time.

    o   Investment - total non-ag, ag machinery, ag
           construction: this equation sets a base level and
           growth rate for each category (default values reproduce
           historical trends); the model automatically reduces the
           base level of investment (e.g., ETAINA) concomitant
           with the reduction in capital stock for recovery which
           then grows at historical rates (e.g., ZETAINA, the
           growth rate can be altered by the anlayst if
           desired)--a provision for entering year by year
           departures from the trend is also provided (e.g.,
           DELTAINA-- the natural log of an analyst-desired change
           in a non-ag investment)

    o   By Sector and Branch - investment flows to sector and
           branch are determined by eogenously set shares of the
           appropriate investment aggregate (after the aggregates
           are adjusted in the balancing mechanism); default
           values are historical shares (1975), are stored as
           exogenous data, and may be altered by the analyst for
           any year desired

    o   Foreign Trade - the foreign trade equations are really
           two alternative functions linked together-- the SOVMOD
           peacetime formulation and a target function (base
           level, growth rate, and analyst- determined derivation
           as for investment--if the MU variable is set to 1, the
           SOVMOD equation is used, if the KAPPA variable is set
           >0, the target function is used. (Note: If KAPPA is
           set to a value greater than 0, MU = 0).

    o   Government Expenditure - for Rand D budget (P.BRD) and
           administration and other budget (P.BAO), the standard
           target functions are used (default values reproduce
           historical trends--SIGMABRD is the base level, IOTABRD
           is the growth rate and NUBRD is an exogenous deviation
           that may be determined by the analyst.

The setting of these levers is explained in greater detail in preceding sections. Remember, these determine the initial (P.) values which are then subjected to balancing and adjustment. See the checksheet on levers, which follows.

3.   Doing the Simulation

Once analyst levers are set and initial conditions specified, little is involved in running the model. The SIMULATE; command will cause the creation of an input dataset if no dataset with the name SEMREC3 exists. This input dataset will be created according to the search list. Archives containing initial conditions and analyst levers to be set at other than default values should be searched before the archives entered in the search list, by the command:

TROLL.   &SRCHREC3

A sample search list with required archives in addition to the basic data appears in the table following. This is in the form of a macro statement (&SRCHBASE) which was supplied with SEMREC3, along with the listed data archives; but the search list can be created with individual TROLL commands.

When the search list is as desired, merely give the command: SIMULATE; change any levers in coeffieicnt files prior to this, but it does not affect the input DSET. TROLL creates the DSET, analyzes the model and generates the code. It then asks for a simulate command. The model can currently be run from 1973 to 1985 but starting no later than 1976. Given the commands SIMSTART year; DOTIL year; FILESIM followed by a name for the dataset in which simulation values will be filed. When the system prompts a TROLL COMMAND the simulation has been completed. You can obtain solution values for specified variables with the PRTDSET command (see preceding sections).

Table IV-3

Sample Search Lists for SEMREC3

Basic Data

Macro SRCHREC3

TROLL COMMAND. &SRCHREC3

(Executes the following)

        DELSEARCH ALL;
        SEARCH FIRST   DATA _ SHARES   (factor shares of GVO)
                         DATA _ INV   (other final demand)
                         DATA _ MISC   (default files for levers)
                         DATA _ DBASE   (final demand definitions)
                         DATA _ ENEINT
                         DATA _ ENERGY   (energy block variables)
                         DATA _ FLOW 1   (GVOs)
                         DATA _ BALANCE   (special balancing variables)
                         DATA _ IO2   (I-o coefficients)
                         DATA _ MINPUT   (material inputs)
                         DATA _ USSR   (basic SOVMOD databank)

SAMPLE SCENARIO DATA

Macro SRCHBASE

TROLL COMMAND. &SRCHBASE

(Executes the following)

        &SRCHREC3
        SEARCH FIRST   DATA _ BASEXM4
                         DATA _ BASEXM   (foreign trade levers)
                         DATA _ BASEC2   (consumption levers)
                         DATA _ BASEI   (investment levers)
                         DATA _ BASEK   (capital stock reductions)
                         DATA _ NCD   (population changes)

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Table IV-4

Checksheet for Analyst Levers

Lever	Name	Stored As	Comment
Labor/Capital Ratios	RNKEP, etc.	coefficients	default = 1975 values
Balance/Adjustment Weights	A01-A20	coefficients	default = 1.0
	A21-A40		default = 1.0
Consumption Targets	GAMMAD, etc.	exogenous variable	multiplier on per-capita default = 1.0
	BETAD, etc.	exogenous variable	growth parameter, default = historical
Investment Targets	DELTAINA, etc.	exogenous variable	log of multiplier, one-time shock default = 0
	ZETAIAM, etc.	exogenous variable	growth parameter default = historial
Investment Shares and Military Procurement.	IRMB9, etc.	exogenous variable	default = 1975 values ag. + non ag. must = 1; sum of shares for sectors must = 1; sum of shares for branches of industry must = 1
Military Durables	MDMIDP	exogenous	analyst target (see p I-45)
Foreign Trade	MU1 through MU25	exogenous variable	MU = 1 peacetime formulation. MU = 0, SEMREC formulation (default)
	KAPPA1 through KAPPA25	exogenous variable	if MU = 1, then KAPPA can be set to fraction of historical trend to be maintained (default, KAPPA = 1)
	PSI1 through PSI28	exogenous variable	log of multiplier, one time shock, default = 0
	RHO1 through RHO28	exogenous variable	growth parameter, default = historical
Government Expenditure	NUBAO and NUBRD	exogenous variable	log of multiplier, one time shock, default = 0
	IOTABAO and IOTABRD	exogenous variable	use default
	SIGMABAO and SIGMABRD	exogenous variable	use default

Table IV-4 (Cont'd)

Checksheet For Analyst Levers

Lever	Name	Stored As	Comment
Initial Conditions Population	NPOP9 and NPOPAB9	exogenous variable	actual population estimates, default is demographic projections
Capital Stock Reduction	DKICP, etc.	exogenous variable	fraction of capital stock reduction (25%, DKICP = .25) default = 0
	RXTGAN, RXTOIP		Declines back to 1 over period

1. Coefficients are changed by CEDIT COMMAND.

2. Exogenous variables are generated by DEDIT COMMAND, create archives for simulation SEARCH list.

3. To obtain values for each lever of a class. (exogenous variables DELTA ___, for example) type PRTDATA DELTA***. To print every variable in an archive, (BASEK, for example) use PRTDATA BASKET _ >.

NOTE: For guidance in setting analyst levers, see SEMREC3A; Baseline Soviet Recovery Case; CEPR-TN-8156-2.

APPENDIX I:
SEMREC User's Guide: Revised Model with
Disequilibrium Adjustment

I.   Introduction

The current version of the SEMREC model is the result of a major
revamping of the disequilibrium adjustment mechanism which was used in the
SEMREC2 model presented in the last revision of the User's Guide. This
respecification means that SEMREC3A represents an improved tool for the
analyst and will provide a more realistic picture of the recovery process
via the imposition of internal consistency with respect to the sources and
uses of sectoral outputs both for material inputs (intermediate uses) and
final uses.

The respecification of the disequilibrium adjustment mechanism
involved the elaboration of the final demand matrix for the base year for
an expanded number of final demand categories and including all sectors so
that balance could be insured. The adjustment algorithm was expanded to
provide for adjustments of final expenditure categories as well as outputs.
The input-output based final demand categories had to be carefully related
to the model concepts for expenditures based on GNP accounting.

The inclusion of final expenditure adjustments as part of the
balancing scheme also permitted the respecification of the consumption and
investment blocks which provides for a more satisfactory mode of analyst
intervention in end-use determination than had been the case in the earlier
versions. The analyst is now able to set targets for consumption and
investment items (in terms of initial levels and growth rates). The values
for these variables are then adjusted to provide for balance in the
production and use of sectoral and branch outputs. In addition, the
foreign trade block from the SOVMOD peacetime model has been modified to
incorporate analyst-determined assumptions about the levels and composition
of foreign trade in recovery and included in SEMREC III, whereas trade

flows were completely exogenous in earlier versions. Trade flows are also
adjusted by the balancing mechanisms.

Because the disequilibrium adjustment mechanism now adjusts gross
value of output rather than the CIA output index (1970=100) for the
branches and sectors, gross values of output production functions have
replaced the earlier form. Rather than the straight two-factor Cobb-
Douglas formation, after estimating a broad variety of specifications,
three-factor (capital, labor, and material inputs) functions with
constrained factor shares and an estimated returns-to-scale parameter were
selected. Thus, inter-sectoral deliveries are already considered, albeit
at an aggregated level, in determining the outputs before they enter the
balancing system. Because the output indices are still used to calculate
GNP by sector of origin, linking equations relate the adjusted gross values
of output to output index values (note this is a reversal of the linking
process in the SEMREC2 specification).

As a result of these modifications, it is possible to have greater
confidence in the implications derived from model simulations than for
earlier versions of the model, primarily due to the intersectoral
relationships that are modeled, as well as the links between output and
end-uses. Moreover, an increased number of analyst levers coupled with
improved implementation of the analyst's choices have been incorporated
into the model specification.

II. The Balancing and Adjustment Mechanism

A. Purpose

As the path of a model simulation increasingly departs from historical experience, the possibility becomes greater that forecasted rates of growth among sectors and end-use components will become inconsistent with the intersectoral relationships and output-end-use relationships dictated by production technology and the composition of end-use aggregates. This, of course, is the case in simulating a recovery scenario.

It is therefore necessary to insure balance in the output and uses (both intermediate and final) of output in the production sectors. The initial values of gross value of output and final expenditure categories produced by the macro-model equations are adjusted to provide for that balance. The adjustments are made by the model in such a manner as to minimize an objective function that is a weighted sum of the squares of the individual adjustments, that is the deviations from the initial targets for the production and expenditure variables.

The SEMREC3A balancing mechanism improves on the earlier version in a number of aspects which provide for more satisfactory performance. It is more comprehensive in that adjustments are made in both outputs and expenditure variables, thus increasing the ability of the system to find a satisfactory solution. The base-year final demand matrix, critical to the calculation of the sectoral output balances, is complete in terms of producing sectors and end-use categories and thus the coefficients are derived from a balanced matrix in compatible prices (1970 producers prices). Conceptual inconsistencies between the model's GNP accounting and the Soviet national income (net material product) concepts used in the reconstructed input-output tables have been reconciled in the new model.

B. Structure

The balancing system calculates adjustments to initial output and expenditure values via the simultaneous solution of the first-order conditions for the minimization of the objective function. The objective function is a weighted sum of the squares of the individual adjustments, where the weights reflect the priority attached to the specific output or expenditure category (i.e., the greater the priority attached by the analyst to a target the higher the weight attached to a deviation from the initial value). That is, it is the objective to minimize the value of D, where

$$D = d\sum_\ell w_\ell \ (y_\ell - y_\ell^0)^2 + r\sum_i s_i \ (x_i - x_i^0)^2$$

and y_ℓ = adjusted expenditure level

y_ℓ^0 = initial expenditure level

w_ℓ = weight associated with the ℓth expenditure component

d = weight associated with the expenditure adjustments

x_i^0 = initial output of the ith sector

x_i = adjusted output of the ith sector

s_i = weight associated with the ith sector output

r = weight associated with output adjustments

This minimization is accomplished subject to a number of constraints, namely the balancing of output and uses of output of branches and sectors and the overall balance, i.e.

$$G = (I - A)X \quad \text{(gross values of output less interindustry uses)}$$
$$F = BY + INV \quad \text{(final expenditures + inventory accumulation)}$$
$$F = G \quad \text{(sector and branch balances)}$$

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where b_{ij} = element of matrix B, output of sector i delivered to final expenditure category j per ruble of expenditure in that category in the base year

A = the input-output technology matrix

INV_i = the final demand residual for sector i, inventory accumulation and statistical discrepancy

$(I-A)_{ik}$ = i,k element of matrix (I-A)

The Lagrangian Z is then formed:

$$Z = d \sum_\ell w_\ell (y_\ell - y_\ell^0)^2 + r \sum_i s_i (x_i - x_i^0)^2 +$$
$$+ \sum_i \lambda_i \left\{ \sum_k (J-A)_{ik} x_k - INV_k - [b_{i\ell} y_\ell + \sum_j b_{ij} y_j] \right\}$$
$$j \neq \ell$$

Differentiating the Lagrangian with respect to y_ℓ and x_k and setting them equal to zero, we obtain the adjustments that minimize the objective function:

- for expenditure adjustments

$$\frac{\partial Z}{\partial y\ell} = 0 = 2d \, w_\ell (y_\ell - y_\ell^0) - \sum_i \lambda_i b_{i\ell}$$

(note that $\sum_i b_{i\ell} = 1$ and that it is assumed that INV is not a function of any y)

- for output adjustments

$$\frac{\partial Z}{\partial x_k} = 2 \, rs_k (x_k - x_k^0) + \sum_j \lambda_j (I-A)_{jk} - \lambda_k \frac{\partial \, INV_k}{\partial \, x_k}$$

and then let $\sum \frac{1}{w_\ell} = 2d$ and $\sum \frac{1}{s_k} = 2r$.

This balancing scheme assumes that some sectors are not balanced individually. If the opposite were there, the overall constraint would merely be the sum of the individual constraints, and the set of constraints would not contain all mutually independent elements.

The weights w_ℓ and s_1 consist of two parts (explicitly coded in the model), a scaling factor and a relative weight. While the scaling factor is not altered by the analyst, the relative weights are important analyst levers for directing the impact of the adjustment mechanism away from high priority targets. A typical adjustment equation is coded as follows:

$$0 = \text{WSUMI} * \text{A01/W01} ** 2 * (\text{XIOME} - \text{P.XOME}) + \text{L01} + \text{L20} - \ldots$$

Where A01 is the relative weight for the output of the metallurgy branch; WSUMI and W01 are scaling factors. P.XIOME is the initial value and XIOME the adjusted value for gross value of output of metallurgy. The adjustment equations are solved simultaneously with the balance constraints to obtain a solution for the desired adjustments. A typical balance equation is coded as:

$$\text{Z01} = \text{G01} - \text{F01} - \text{INV01}$$

where Z01 is exogenously set to zero, i.e., the production and uses of output in sector 01 (metallurgy) are required to be in balance. G01 is the output of metallurgy less interindustry uses which is the output available for final delivery:

$$\text{G01} = \text{XIOME} - \sum_{i=1}^{18} a_{i,01} * \text{XIO}_i \ ,$$

where the a_{ij} are coefficients of the input-output matrix. F01 is the sum of final expenditures on metals output

$$\text{F01} = \sum_{j=1}^{20} b_{j,01} Y_j \ ,$$

where the b_{jk} are the coefficients of the final demand matrix and the Y_j are the final expenditure categories (food consumption, durables consumption, etc.). INV01 is the inventory accumulation and statistical discrepancy for sector 01, which is predicted by a typical inventory equation (a function of current and/or lagged gross value of output of the sector):

$$INV01 = CF200+CF201+XIOME+CF202*QT50+CF203*Q67$$

where QT50 is a time trend and Q67 a dummy variable which removes the anomalous observation for 1967, the year of a major price reform.

The following sectors are constrained to be in balance:

01	metallurgy	07	chemicals	12	processed food
02	coal and peat	08	forest products	14	construction
03	oil	09	paper and pulp	15	agriculture
04	gas	10	construction materials		
06	machine-building and metalworking	11	soft goods		

Note that the residual sectors, industry, n.e.c., and Other Branches, are not checked for balance nor are the service sectors, transport and communication and trade and distribution. Electric power, because of the specification of the energy block is always in balance, i.e., production is set equal to usage. Transport and communications and Distribution and trade are also set equal to calculated requirements.

The outputs of all sectors listed above are adjusted. The relative weights (A01 for sector 01, etc.) are initially set to values determined in calibrating the model, but can be altered by the analyst to alter the pattern of adjustments if he feels it appropriate. The desired values for the weight would be obtained through iterative simulation experiments.

Aside from the balances and output adjustments, the mechanism also requires that the model expenditure concepts (from reconstruction of Soviet accounts by Western analysts) be translated into concepts compatible with the final demand matrix (Soviet national income and input-output concepts).

These translated concepts represent initial values which are then adjusted
by the model and translated back to the model's GNP-accounting concepts.
The relationships between the two alternative sets of accounting concepts
are described in the sections below on the final demand matrix. The
following final demand categories are adjusted by the mechanism (that is,
they are the y_j in the exposition above:

21	CFPR	consumption expenditures, food
22	CNPR	consumption expenditures, other non-durables
23	CDPR	consumption expenditures, durables
24	CSPR	consumption expenditures, services
25	GPHS	government expenditures, public housing and services
26	GNTC	government expenditures, non-productive transport and communications
27	GHEC	government expenditures, health, education," and culture
28	GSBA	government expenditures, science, banking and administration
29	ERPR	exports, raw materials
30	EMPR	exports, machinery
31	EFPR	exports, food
32	ECPR	exports, consumer goods
33	MRPR	imports, raw materials
34	MMPR	imports, machinery
35	MFPR	imports, non-grain food
36	MCPR	imports, consumer goods
37	MGPR	imports, grain
38	IM	investment, machinery component
39	IC	investment, construction component
40	IRIO	capital repair expenditures

C.   Elaboration of Final Demand Relationships

1. Purpose

The disequilibrium adjustment mechanism of the model requires determination of the degree of balance of the output of each sector and the sum of interindustry uses and final demand. Interindustry uses are calculated via the input-output coefficients ($\underline{A}$ matrix) derived from a series of balanced 18-sector flow tables in 1970 rubles and the gross values of output (GVO) from a set of production functions relating GVOs to factor inputs. Having deducted the interindustry uses from GVO, output available for final deliveries is obtained (eq. 5.1)

$$(5.1) \quad G_i = XIO_i - \sum_{j=1}^{18} a_{ij} XIO_j$$

where the G_i = output available for final delivery of sector i

XIO_i = gross value of output of sector i

a_{ij} = input requirement of sector i per ruble of GVO of sector j

Against this vector, a vector of final demands must be balanced. This requires not only levels of end-use generated by the model, but also information on the sectoral composition of the end-use components. Information consistent with reconstructed Soviet input-output data is available for the benchmark years - 1959, 1966, and 1972. The 1966 data were selected as the base year, not only because they represent a mid point, but also because of the greater detail available on deliveries within the final demand quadrant. It was necessary to accomplish the following steps to formulate the required matrix:

(1) Obtain information on columns in the final demand matrix in as disaggregated form as possible to reflect shifts in composition of end-use aggregates over time;

(2) Convert this data, where necessary, to 1970 producers prices in order to be consistent with the input-output coefficient time series;

(3) Relate the column totals to model-generated variables for the base year;

(4) Insure balance, since no balanced final-demand matrix with all the required columns was published.

Upon completing the procedure it was then possible to calculate a balance equation for each sector (eqs. 5.2-3).

$$(5.2) \quad F_i = \sum_{j=1}^{24} b_{ij} Y_j$$

$$(5.3) \quad Z_i = G_i - F_i = \text{Balance}$$

where F_i = final demand deliveries of output of sector i

Y_j = total expenditures for end-use category j

b_{ij} = share of deliveries by sector i of total end-use of category j

Initial production levels generated by the production functions are fed into the balances and the disequilibrium mechanism adjusts sectoral outputs to insure balance.

The earlier version of the disequilibrium adjustment mechanism provided for similar final demand calculations, however they did not assure complete allocation of expenditures in the base year, energy sectors were balanced in physical terms outside the final demand matrix and there were no balances for the service sectors. This new elaboration attempts to insure consistency and balance in the base year final demand matrix for all sectors together with an expanded set of final demand categories.

2. Construction of the Final Demand Columns

A number of versions of the final demand quadrant for the reconstructed 1966 Soviet input-output table have been published by the Duke University - Foreign Demographic Analysis Division Soviet Input-Output Project with alternative disaggregations in 1966 purchasers' prices, 1966 producers' prices, and 1970 producers' prices.[1] Unfortunately, in the producers' price tables, final demand was not disaggregated further than private consumption, public consumption, and other final demand. Other final demand represents the sum of net exports and gross investment (accumulation in Soviet statistics) which are indicated separately in the purchasers' price tables. Moreover, 1970-based price indexes were available only for flows in producers' prices.[2] The 1966 purchasers price table with supplementary data provides an additional disaggregation of public consumption--public housing and services, non-productive transport and communications, health, education and culture, and science, banking, and administration.

The columns required for the final demand matrix, at a minimum, include:

private consumption	public consumption
exports	imports
fixed investment	capital repair
inventory investment	defense procurement

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[1] See Vladimir G. Treml, ed., Studies in Soviet Input-Output Analysis, Praeger, New York, 1977 for 1966 tables in 1966 purchasers' prices (Table 1.1, pp. 10ff.) 1966 producers' prices (Table 1.2, pp. 31ff.) aggregated with supplementary final demand data in 1966 purchasers' price (Table 1.3,) pp. 52 ff.) and 1970 producers' prices (Table 5.1 pp. 204ff.)

[2] See Vladimir Treml, Price Indexes for Soviet 18-Sector Input-Output Tables for 1959-75, SRI Technical Note SSC-TN-5943-1, June 1978. These indices incorporate some corrections and revisions not reflected in 1970 price table cited previously.

in order to derive sectoral composition of end-use components deter-
mined by the model blocks. In addition it was desirable to further dis-
aggregate some of the major categories in order to minimize the impact
of the changing composition of the broader category over time relative to
that in the base year.

a.   Private Consumption

Although private consumption appears in the reconstructed tables
as a single column it was decided to disaggregate the category into consump-
tion of food, non-durables, durables, and services, with the delivery of
each sector to private consumption allocated to only one subcomponent
according to the general character of the output of the sector.[1]

Sectoral deliveries of the non-service sectors were calculated by
aggregating the 76-sector entries in the private consumption column of
the 1966 producers' price table (Treml, 1977) into 16 non-service sectors
and applying the price indices developed by Treml for the time series of
18-sector tables in 1970 producers' prices (Treml, 1978, see footnote 2 on
page 12). No separate price indices were available for trade and distribu-
tion or transport and communication. Therefore, the methodology developed by
Treml and Guill which used the 1972 ratios of sectoral deliveries in
producers' prices to the distribution and trade and transport and communi-
cations entries to derive entries for these sectors for tables in 1970

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[1]The trade and distribution and transport and communications sectors are
an exception. Deliveries of these sectors to consumption in a producers'
price table represent these functions in the cost of delivery of the
non-service sectors to consumption and thus are entered into each subcomponent.

producers' prices was applied (see Table A-5.1).[1] Thus, entries for the two productive services sectors were obtained for each of the categories of consumption (private and, see below, public consumption categories).

b. Public Consumption

The deliveries of sectors to total public consumption were obtained in the same manner as those for private consumption, that is, aggregation of 1966 producers' price entries and the application of Treml's price indices and trade and transport ratios. It was desirable, however, to disaggregate this category, both for the reason of changing composition among sub-components and better to relate the input-output concept to expenditure categories in the model.

More detailed information on public consumption is provided in Treml (1977-Table 1.3) in an aggregated purchasers' price table for 1966 with supplementary final demand data. Public Consumption is disaggregated into four columns:

Public Housing and Services

Non-productive Transport and Communications

Health, Education, and Culture, and

Science, Banking, and Administration.

For each sector, the ratio of the delivery to each subcomponent to the sum of deliveries to public consumption in the reconstructed table was used to distribute the delivery of the sector in 1970 producers' prices to each of the four subcomponents.

[1] See Gene D. Guill, Deflation of the 18-Sector Soviet Input-Output Tables, SRI Technical Note SSC-TN-5943-4, August 1978, pp. 21-23. It should be noted that while the methodology was correctly stated, an error has since been discovered in the calculation of final demand for the trade and distribution sector, thus leading to incorrect entries for GVO and value added plus depreciation for that sector as well as total final demand and GVO, for each year. Corrected entries were determined for this study.

Table A-5.1

CALCULATION OF TOTAL FINAL DEMAND ENTRY FOR
DISTRIBUTION AND TRADE FOR 1966

For each year $\quad FD_{17} = \sum_{i=1-13,15,18} \alpha_i (FD_i)d_i + (1 - \alpha_i)(FD_i)S_i$

		$\alpha_{i,1966}$	d_i	S_i	FD_i	$FD_{i,17}$
1.	Metallurgy	.2933	.0189	.0179	2313112	42083
2.	Coal and Peat	.8195	.0256	.0320	1326714	35496
3.	Oil	.2191	.0348	.0675	1947093	117479
4.	Gas	.4629	0	.0520	210930	5891
5.	Electric Power	.9859	0	0	1654031	0
6.	MBMW	.1384	.1224	.0098	36396068	923868
7.	Chemicals	.7329	.2645	.0155	2340239	463349
8.	Forest Products	.6061	.0764	.0238	3398237	189216
9.	Pulp & Paper	.7844	.4230	.0411	81696	27830
10.	Construction Materials	.9425	.4009	.0102	688512	260556
11.	Soft Goods	1.166	.0823	.0017	17722064	1698490
12.	Processed Foods	1.011	.1603	.0066	40163655	6506110
13.	Industry, NEC	1.144	.0433	.0074	3204560	155323
15.	Agriculture	.7655	.0404	.0652	30790098	1422983
18.	Other Branches	.9743	.2676	.0122	2426640	633438

then for each year $\quad GVO_{17} = $ interindustry use $+ FD_{17}$

where

$\alpha_{i,1966} = \dfrac{\text{private consumption} + \text{public consumption of sector i, 1966}}{\text{total final demand for sector i, 1966}}$

(interpolated between benchmark years)

d_i = distribution charge attributed to one ruble of sector i output delivered to consumption

S_i = supply charge attributed to one ruble of sector i output delivered to all other uses

FD = final demand in thousands of rubles

Table A-5.14

a_f, 1959-1975

Share of Consumption in Final Demand for Sector i

Sector	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Metallurgy	.2054	.2180	.2305	.2431	.2556	.2682	.2807	.2933	.3103	.3273	.3444	.3614	.3784	.3954	.4156	.4368	.4591
Coal and Peat	.5279	.5696	.6112	.6529	.6945	.7162	.7778	.8195	.8491	.8787	.9083	.9378	.9674	.9970	1.0301	1.0643	1.0997
Oil	.2809	.2721	.2632	.2544	.2456	.2368	.2279	.2191	.2265	.2339	.2413	.2486	.2560	.2634	.2716	.2801	.2888
Gas	.6313	.6072	.5832	.5591	.5351	.5110	.4870	.4629	.5287	.5944	.6602	.7259	.7917	.8574	.9502	1.0530	1.1669
Electric Power	.9091	.9201	.9310	.9420	.9530	.9640	.9749	.9859	.9991	1.0123	1.0255	1.0386	1.0518	1.0650	1.0788	1.0928	1.1069
MBMW	.2365	.2225	.2085	.1945	.1804	.1664	.1524	.1384	.1375	.1365	.1356	.1346	.1337	.1327	.1318	.1309	.1299
Chemicals	.7780	.7716	.7651	.7587	.7522	.7458	.7393	.7329	.7101	.6873	.6645	.6416	.6188	.5960	.5758	.5563	.5375
Forest Products	.6453	.6397	.6341	.6285	.6229	.6173	.6117	.6061	.6385	.6710	.7034	.7358	.7483	.8007	.8387	.8786	.9203
Paper and Pulp	1.1530	1.1003	1.0477	.9950	.9424	.8897	.8371	.7844	.6967	.6089	.5212	.4335	.3457	.2580	.2144	.1781	.1480
Construction Materials	.9922	.9851	.9780	.9709	.9638	.9567	.9496	.9425	.9305	.9365	.9335	.9304	.9274	.9244	.9214	.9184	.9155
Soft Goods	.9652	.9942	1.0231	1.0521	1.0811	1.1101	1.1390	1.1680	1.1793	1.1906	1.2019	1.2132	1.2245	1.2358	1.2475	1.2593	1.2712
Processed Foods	.9244	.9368	.9491	.9615	.9739	.9863	.9986	1.0110	1.0092	1.0074	1.0056	1.0038	1.0020	1.0002	.9984	.9966	.9948
Industry, N.E.C.	.8900	.9263	.9626	.9989	1.0351	1.0714	1.1077	1.1440	1.1322	1.1204	1.1087	1.0969	1.0851	1.0733	1.0620	1.0507	1.0396
Construction	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Agriculture	.9433	.9179	.8925	.8671	.8417	.8163	.7909	.7655	.8056	.8457	.8858	.9258	.9659	1.0060	1.0529	1.1019	1.1533
Transportation & Communication	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trade and Distribution	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other Branches	1.0258	1.0184	1.0111	1.0037	.9964	.9890	.9817	.9743	.9637	.9530	.9424	.9317	.9211	.9104	.9002	.8900	.8800

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c. <u>Exports and Imports</u>

Exports and imports are not shown separately in the reconstructed
producers' price tables, but rather net exports are included in an other
final demand column. Because it was necessary to relate model values
for trade flows by commodity group to balances for individual sectors,
export and import columns for the base year final demand quadrant in
1970 producers' prices had to be estimated. Export flows in 1966 prices
were assumed not to contain turnover tax components. They were inflated
by price conversion factors for final demand at the 76-sector level in-
dicated in Treml and Guill's study on price conversion of the 1966 table
(Treml, 1977-Table 5.2), and aggregated to 16 non-service sectors.

Import flows were assumed to contain turnover tax components.[1]
The import share of turnover tax implied by the other final demand entry
for tax on purchases in the 1966 producers' price table (Treml, 1977-
Table 1.2) was shared out proportionately and deducted from the 76-sector
import entries in purchasers prices. These were then converted to 1970
prices with the conversion factors and aggregated to 16 non-service sectors.

In an effort to account for effects of the changing commodity compo-
sition of trade flows over
columns were disaggregated into subcomponents of major commodity groups:

Exports	Imports
Raw Materials	Raw Materials
Machinery and Equipment	Machinery and Equipment
Foodstuffs	Non-Grain Food
Consumer Goods	Grain
	Consumer Goods

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[1] See Treml, op. cit., 1978.

This disaggregation also relates well to the commodity groupings of the model's trade block. As in consumption, each sector's deliveries were wholly allocated to one subcomponent according to the general character of output. An exception to this procedure was made in the case of Industry N.E.C. and Other Branches (Sectors 13 and 18). For these sectors, use was made of the foreign trade handbook to estimate appropriate splits of deliveries between raw materials and consumer goods subcomponents, and to split agricultural imports into non-grain and grain components.[6]

d. Gross Investment

It was assumed that fixed investment and capital repair of equipment consist only of deliveries from the MBMW sector (and concomitant entries for the trade and distribution and transport sectors, about 5 percent of the purchasers' price value for MBMW final deliveries of producers investment goods, per Vladimir Treml). For fixed investment, the MBMW purchasers' price delivery was taken as the official Soviet investment durables figure for 1966. The MBMW delivery to capital repair was taken as the delivery of the repair sector to other final demand in Treml and Guill's 1970 price table (Treml, 1977-Table 5.1). The gross investment component of the transport and communications final demand entry (per advice of V. Treml) was allocated proportionately to investment in equipment and capital repair. The trade and distribution entry for investment in producers' equipment was the residual of the 5

[6]On this last split, see also Foreign Agricultural Service, USSR Agricultural Trade 1955-77, U.S.D.A., August 1978.

percent service component. The capital repair trade and distribution
entry was obtained from the proportionality between the two service
entries in the investment equipment column.

The construction component of the capital repair column is the column
residual given the entries for the MBMW, T & C, and T & D rows. The
column total is the product of the 1966 value of the 1970-based capital repair
index produced by CIA's Office of Economic Research and their 1970 value for
capital repair in the reconstructed GNP accounts.

The last remaining entry required for the fixed investment category
is the distribution of the deliveries of the construction sector. Based
on data from official Soviet statistical handbooks, it appears that taking
the distribution of capital investment expenditures, excluding the durables
component, results in an overestimate for this entry by the amount of
losses, and other outlays (such as for site preparation). Vladimir
Treml suggested using the sum of the volume of construction and assembly
work performed (contract and sectors' own-force construction, including
that by collective farms), the volume of design work, and investment in
individual housing.

e. Other Final Demand Items

Given the sectoral final deliveries in 1970 producers' prices
from Guill's series of 18-sector tables (Guill, 1978), modified for the
distribution sector, and the calculated entries for public and private
consumption, exports, imports, fixed investment and capital repair, a
residual for each sector was obtained. These residuals in the base year
should represent inventory change (including the change in unfinished

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construction, net additions to livestock herds), residual defense items not included in public and private consumption and fixed investment, losses, and sectoral statistical discrepancies. Separation of residuals into subcomponents has been undertaken (see Table A-7.1).

Given inventory change, change in livestock herds, and change in unfinished construction, remaining residuals, aside from those arising from statistical sources, might be attributable to defense end-use. According to Treml, the appropriate item is defense procurement, because other components of defense expenditures are incorporated into public and private consumption. Thus the residual of concern here is that in the MBMW row. In the GNP accounts a portion of this residual (procurement of non-military durables by the defense establishment) is associated with inventory change--in 1970, between 1.0 and 2.0 billion rubles.[1]

This series of calculations from reconstructed input-output tables, the Soviet handbooks, and Office of Economic Research series resulted in an elaborated final demand matrix for 1966 in 1970 producers' prices. The results are presented in Tables A-5.2 and A-5.3.

D. Relation of Model Expenditure Categories to the Final Demand Matrix

Due to the expertise and additional information represented by reconstructed data published. by CIA's OER and by individual Western scholars, SOVMOD's specification has been based on the Western accounting concepts employed in these reconstructions which are incorporated into the model database.

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[1]John Pitzer, Reconciliation of Gross National Product and Soviet National Income, NATO Colloquim Paper, December 1977, p. 29.

TABLE A-5.2

1966 FINAL DEMAND MATERIAL ALLOCATIONS

("B" MATRIX)

(Millions of 1970 Rubles, Producers' Prices)

Final Category Demand/Symbol — Sector	Private Consumption					Total CIO	Public Housing & Services GHRC	Public Consumption		
	Total CIO	Food CFPR	Other Non-Durables CNTR	Durables CNPR	Services CSPR			Non-Productive Transport & Communications GNTC	Health Education & Culture GHEC	Science Banking & Administration GSBA
01 Metallurgy	10				10	668	26	27	9	605
02 Coal and Peat	182				182	905	210	329	212	153
03 Oil	84				84	343	80	125	80	58
04 Gas	64				64	33	8	12	8	6
05 Electric Power	892				892	739	187	134	269	149
06 MBMW	3,548			3,548		1,348	92	206	171	878
07 Chemicals	634				634	1,116	77	114	466	459
08 Forest Products	2,211			2,211		445	112	37	121	185
09 Pulp and Paper						77	19	6	21	31
10 Construction Materials	208			208		210	52	18	58	82
11 Soft Goods	19,934		19,934			771	76	37	526	112
12 Processed Food	38,283	38,283				2,314	34	17	2,225	38
13 Industry, N.E.C.	3,145		3,145			521	81	84	321	35
14 Construction										
15 Agriculture	23,421	23,421				548	114	131	548	
16 Transportation and Communications	2,436	1,464	291	537	144	679	93	91	226	208
17 Distribution and Trade	10,300	7,660	1,776	686	178	1,193			684	325
18 Other Branches	2,161	2,161				203			203	
Subtotal		72,989	25,146	7,200	2,178	12,123	1,261	1,368	6,148	3,344
TOTAL	107,513									

Table A-5.2 (continued)

1966 FINAL DEMAND ALLOCATIONS

Final Category Demand/Symbol — Sector	Total EIU	Exports				Total MIU	Imports				
		Raw Materials Exports ERPR	Machinery EMPR	Food EFPR	Consumer Goods ECPR		Raw Materials MRPR	Machinery MMPR	Non-Grain Food MFPR	Consumer Goods MCPR	Grain MGPR
01 Metallurgy	3,205	3,205				960	960				
02 Coal and Peat	396	396				287	287				
03 Oil	1,885	1,885				86	86				
04 Gas	24	24									
05 Electric Power	23	23									
06 MBMW	1,856		1,856			1,793		1,793			
07 Chemicals	472	472				791	791				
08 Forest Products	770	770				262	262				
09 Pulp and Paper	123	123				118	118				
10 Construction Materials	36	36				28	28				
11 Soft Goods	728				728	4,716				4,716	
12 Processed Food	380			380		1,294			1,294		
13 Industry, N.E.C.	58	34			24	134	45			89	
14 Construction											
15 Agriculture	362			362		1,245			447		798
16 Transportation and Communications											
17 Distribution and Trade											
18 Other Branches	38	32			6	17	14			3	
Subtotal	7,000	7,000	1,856	742	758	11,731	2,591	1,793	1,741	4,808	798
TOTAL	10,356					11,731					

Table A-5.2 (continued)

1966 FINAL DEMAND ALLOCATIONS

Final Demand Category/Symbol — Sector	Fixed Investment — Equipment IM	Construction IC	Capital Repair IR	Other Final Demand Items	Final Demand
01 Metallurgy				-510	2,313
02 Coal and Peat				131	1,327
03 Oil				-279	1,947
04 Gas				90	211
05 Electric Power				1,654	1,654
06 MBMW	17,575		7,224	6,638	36,396
07 Chemicals				909	2,340
08 Forest Products				224	3,398
09 Pulp and Paper				82	82
10 Construction Materials				263	689
11 Soft Goods				1,005	17,722
12 Processed Food				481	40,164
13 Industry, N.E.C.				-385	3,205
14 Construction		39,100	7,383	7,254	53,737
15 Agriculture				7,704	30,790
16 Transportation and Communications	721		284	998	5,118
17 Distribution and Trade	204		75	710	12,482
18 Other Branches				42	2,427
TOTAL	18,500	39,100	14,966	25,175	215,949

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Table A-5.1

COEFFICIENTS DERIVED FROM MATRIX
OF FINAL DEMAND MATERIAL ALLOCATIONS

Final Category Demand/Symbol / Sector	Private Consumption						Public Housing & Services CPHS	Public Consumption Non-Productive Transport & Communications CNTC	Health Education & Culture CHEC	Science Banking & Administration CSBA
	Total CIO	Food CFPR	Other Non-Durables CNPP	Durables CDPR	Services CSPR	Total CIO				
01 Metallurgy	.0001	--	--	.0014	--	.0551	.0206	.0197	.0015	.1809
02 Coal and Peat	.0017	--	--	--	.0836	.0747	.1665	.2405	.0345	.0458
03 Oil	.0008	--	--	--	.0386	.0283	.0634	.0914	.0130	.0173
04 Gas	.0006	--	--	--	.0294	.0027	.0063	.0088	.0013	.0018
05 Electric Power	.0083	--	--	--	.4096	.0610	.1483	.0980	.0438	.0446
06 MBMW	.0130	--	--	.4928	--	.1112	.0730	.1506	.0278	.2626
07 Chemicals	.0059	--	--	--	.2911	.0921	.0611	.0833	.0758	.1373
08 Forest Products	.0206	--	--	.3071	--	.0375	.0888	.0270	.0197	.0553
09 Pulp and Paper	--	--	--	--	--	.0064	.0151	.0044	.0034	.0093
10 Construction Materials	.0019	--	--	.0289	--	.0173	.0412	.0132	.0094	.0245
11 Soft Goods	.1854	--	.7927	--	--	.0636	.0603	.0270	.0856	.0395
12 Processed Food	.3561	.5245	--	--	--	.1909	.0270	.0124	.3619	.0114
13 Industry, N.E.C.	.0293	--	.1251	--	--	.0430	.0642	.0614	.0522	.0105
14 Construction	--	--	--	--	--	--	--	--	--	--
15 Agriculture	.2178	.3209	--	--	--	.0452	--	--	.0891	--
16 Transportation and Communications	.0227	.0201	.0116	.0746	.0661	.0560	.0904	.0958	.0368	.0622
17 Distribution and Trade	.0958	.1050	.0706	.0953	.0817	.0984	.0738	.0665	.1113	.0972
18 Other Branches	.0201	.0296	--	--	--	.0167	--	--	.0330	--
TOTAL [1]	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

[1] Detail may not add to totals due to rounding.

Table A-5.3 (Continued)

Final Category Demand/Symbol Sector	Exports					Imports					
	Total FIO	Raw Materials Exports ERPR	Machinery EMPR	Food EFPR	Consumer Goods IGPR	Total MIO	Raw Materials MRPR	Machinery MCPR	Non-Grain Food MFPR	Consumer Goods MCPR	Grain MGPR
01 Metallurgy	.1095	.4579	--	--	--	.0818	.3705	--	--	--	--
02 Coal and Peat	.0382	.0566	--	--	--	.0245	.1108	--	--	--	--
03 Oil	.1820	.2693	--	--	--	.0074	.0332	--	--	--	--
04 Gas	.0023	.0034	--	--	--	--	--	--	--	--	--
05 Electric Power	.0022	.0013	--	--	--	--	--	--	--	--	--
06 MBMW	.1792	--	1.0000	--	--	.1528	--	1.0000	--	--	--
07 Chemicals	.0456	.0674	--	--	--	.0674	.3053	--	--	--	--
08 Forest Products	.0744	.1100	--	--	--	.0223	.1011	--	--	--	--
09 Pulp and Paper	.0119	.0176	--	--	--	.0101	.0455	--	--	--	--
10 Construction Materials	.0035	.0051	--	--	--	.0024	.0108	--	--	--	--
11 Soft Goods	.0703	--	--	--	.9604	.4020	--	--	--	.9809	--
12 Processed Food	.0367	--	--	.5121	--	.1103	--	--	.7433	--	--
13 Industry, N.E.C.	.0056	.0049	--	.4879	.0317	.0114	.0175	--	--	.0185	--
14 Construction	--	--	--	--	--	--	--	--	--	--	--
15 Agriculture	.0350	--	--	--	--	.1061	--	--	.2567	--	1.0000
16 Transportation and Communications	--	--	--	--	--	--	--	--	--	--	--
17 Distribution and Trade	--	--	--	--	--	--	--	--	--	--	--
18 Other Branches	.0037	.0046	--	--	.0079	.0015	.0052	--	--	.0006	--
TOTAL	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table A-5.3 (Continued)

Final Demand Category / Symbol — Sector	Fixed Investment			Other Final Demand Items IV	Final Demand
	Equipment IM	Construction IC	Capital Repair IR		
01 Metallurgy	--	--	--		
02 Coal and Peat	--	--	--		
03 Oil	--	--	--		
04 Gas	--	--	--		
05 Electric Power	--	--	.4830		
06 MBMW	.9500	--	--		
07 Chemicals	--	--	--		
08 Forest Products	--	--	--		
09 Pulp and Paper	--	--	--		
10 Construction Materials	--	--	--		
11 Soft Goods	--	--	--		
12 Processed Food	--	--	--		
13 Industry, N.E.C.	--	--	--		
14 Construction	--	1.0000	.4940		
15 Agriculture	--	--	--		
16 Transportation and Communications	.0390	--	.0190		
17 Distribution and Trade	.0110	--	.0050		
18 Other Branches	--	--	--		
TOTAL	1.0000	1.0000	1.0000		

Thus, to relate expenditures to sectoral deliveries, the model's expenditure concepts had to be linked to the input-output categories.

Primarily this involved the following tasks:

- Removal of turnover taxes from some expenditure components;

- Shift of services which do not sell output (education, etc.) from private to public consumption;

- Exclusion of non-material components from outlays;

- Conversion of trade flows to 1970 domestic rubles.

After these definitions were established, model values were transformed into the final demand matrix categories and compared with the column totals for the base year. Proportionality factors were then introduced into the definitions in order that values would reconcile exactly with the base year column totals. In most cases the proportionality factors were not very different from unity.

1. Removal of Turnover Taxes

The model's series for consumption and some public sector outlays are in purchasers' prices, and turnover taxes must be removed before relationships derived from the final demand matrix can be applied. Treatment of turnover taxes on imports is discussed in the section on foreign trade (below).

Turnover taxes are estimated in the model in current rubles. Because they will be deducted from consumption expenditures measured in 1970 rubles, the consumption price deflator (1970 base) is applied. Then, the shares of turnover tax allocated to various final demand categories in the 1966 producers' price table (Treml, 1977--Table 1.2) are imposed.[1] The turnover

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[1] It should be noted that only about 70 percent of total turnover taxes are passed on to final demand according to the reconstructed input-output table.

tax for public and private consumption is allocated proportionately among the subcomponents and eventually subtracted from the model values for expenditures.[1]

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[1] The shares of the subcomponents in the expenditure total which are used for these calculations already reflect shifts of outlays between public and private consumption and removal of non-material outlays as discussed in the next section.

2. Public/Private Consumption Shifts and Non-Material Outlays

The model data for private consumption of services is derived from an OER series which includes the following expenditures that relate to public consumption categories in the input-output scheme:

| public housing and services | health |
| education | culture |

In the reconstructed 1970 GNP accounts produced by OER, the following detail is given for consumption of services:[1]

	Billions of Rubles	Share (proportion)
Total	52.363	1.00
including:		
Trade and Union & other dues	2.092	.040
Housing	3.429	.065
Utilities	3.478	.066
Personal Transport	7.200	.138
Personal Communications	1.200	.023
Repair and Personal Care	4.674	.089
Recreation, Art, and Physical Culture	3.948	.075
Education	16.098	.307
Health	10.244	.196

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[1] Pitzer, op.cit., p. 25

These shares were applied to the model's time series for consumption of services and the appropriate subcomponents reallocated to public consumption categories. In the input-output total private consumption column of the base year, there are entries which were allocated to a private consumption of services category. These were related to a share of the model's definition of consumption of services as a fixed proportion of the non-wage component of this category (set at the calculated base year share).

Expenditure components shifted to public consumption matched three of the four public consumption categories in the final demand matrix. The fourth, science, banking, and administration, was related to two model variables--outlays on administration and outlays for research and development. It was then necessary to calculate the material purchases implied by each of these four expenditure categories, since wages and purchases of services by this sector do not enter into Soviet national income. This was accomplished by applying, in each year, the ratio of material purchases to total outlays shown in the aggregated 1966 purchasers' price table augmented with supplementary data (Treml, 1977-Table 1.3). As indicated above, the public consumption share of turnover taxes was then removed (on the basis of 1966 proportions) from each of the four categories.

3. Conversion of Trade Flows

Trade flows modeled in SOVMOD's foreign trade block are current U.S. dollar values published by OER. It was necessary to convert these flows to 1970 domestic rubles. This was accomplished via a four-step process-- conversion from (1) current dollars to current foreign trade rubles;

(2) to 1966 foreign trade rubles; (3) to 1966 purchasers' prices; and

(4) in one step, to 1970 producers' prices (exports are assumed to have

no turnover tax component). That is,

$$\frac{\text{current \$ trade flow}}{\text{exchange rate}} = \text{current foreign trade rubles}$$

$$\frac{\text{current foreign trade rubles}}{\substack{\text{(official Soviet import or} \\ \text{export price deflator rebased} \\ \text{to 1966)}}} = 1966 \text{ foreign trade rubles}$$

(1966 foreign trade rubles) x (domestic/foreign trade = 1966 purchasers'
                             ruble conversion factor   prices
                             for 1966)

(1966 purchasers' prices - turnover tax) x inflator = 1970 producers'
                      (imports only) (see text)   prices

This approach to conversion employs 1966 ruble values because factors to

convert foreign trade to domestic rubles were prepared by the Foreign

Demographic Analysis Division to relate foreign trade data to entries in

the reconstructed 1966 purchasers' price table.[1] Figures in 1966 foreign

trade rubles and domestic rubles were published for flows on a 75-sector

basis. These were aggregated to the commodity group subcomponents for

exports and imports employed here and foreign-domestic conversion ratios

derived. The official Soviet indices for prices paid for imports and

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[1] Barry L. Kostinsky and Vladimir G. Treml, Foreign Trade Pricing in the
Soviet Union: Exports and Imports in the 1966 Input-Output Table, Foreign
Economic Report No. 8, U.S. Department of Commerce, March 1976. See
especially Table 12, pp. 30-32. Note 3 to that table explains the inclusion
of arms exports and imports in the MBMW row and their conve sion to domes c
values. The domestic value for arms exports indicated in the note, however,
appears to be misstated. It has been confirmed that the correct value,
which can easily be determined by applying the methodology described, was
however, used in the body of the table. These values were also used in
calculating the MBMW trade entires for the base year final demand matrix
in section 5 above.

received for exports were taken from foreign trade handbooks. The 1966 and 1970 producers' price inflators were drawn from the calculations described in section C above.

4. Fixed Investment and Capital Repair

Because published input-output reconstructions do not include disaggregations of the gross investment category, our estimates of the base year final demand matrix use data from Soviet handbooks to segregate fixed investment and capital repair from other final demand. These data are consistent with the model concepts except that previous versions of SOVMOD only distinguish between investment construction and machinery components for agricultural investment. As described in section 5 below, the definition of the total construction and machinery components of fixed investment is therefore determined by the historical share of the data series from the handbooks, in total fixed investment for construction, and in non-agricultural investment for machinery plus the model series for investment in agricultural machinery. The capital repair estimates are those prepared by OER.

5. Final Demand Definitions

Employing the methodology described in sections above, the following definitions were used to obtain from model variables appropriate estimated column totals for the final demand flows matrix for other than the base year (the relations contain adjustments which provide for exact correspondence in the base year).

a. <u>Turnover Taxes</u>

Total, 1970 Rubles	TT70	= TT/PCD70*100
Adjusted to IO entry, base year	TT7OIO	= 1.007*TT70

Final Demand Components

Total Final Demand	TT7OIOF	= 0.711*TTOIO
Consumption	TT7OIOC	= 0.9008*TT7OIOF
Imports	TT7OIOM	= 0.0159*TT7OIOF
Public Consumption	TT7OIOG	= 0.0833*TT7OIOF

where PCD70 = Implicit Consumption Price Deflator

TT = Turnover Tax, billions of current rubles

b. <u>Private Consumption</u>

Expenditures in Purchasers' Prices

Food	P.CFPU	= 1.01433*P.CRF70
Other Nondurables	P.CNPU	= 0.91868*P.CRND70
Durables	P.CDPU	= 0.95651*P.CRD70
Services, Net of Wage Comp.	P.CRS70G	= P.CRS70-NMG*1282.83*1.0E-06
Services	P.CSPU	= 0.14305*P.CRS70G
Total	P.CPU	= P.CFPU+P.CNPU+P.CDPU+P.CSPU

Turnover Taxes

Food	P.TT70CF	= TT7OIO*CP.CFPU/P.CPU
Other Nondurables	P.TT7OCN	= TT7OIOC*P.CNPU/P.CPU
Durables	P.TT70CD	= TT7OIOC*P.CDPU/P.CPU
Services	P.TT70CS	= TT7OIOC*P.CSPU/P.CPU

Expenditures in Producers' Prices

Food	P.CFPR	=	CFPU-P.TT70CF
Other Nondurables	P.CNPR	=	CNPU-P.TT70CN
Durables	P.CDPR	=	CDPU-P.TT70CD
Services	P.CSPR	=	CSPU-P.TT70CS
Total	CIO	=	CFPR+CNPR+CDPR+CSPR

where NMG = Employment, Government and Services (thousands)

CRF70 = Food Consumption, billions of 1970 rubles, etc.

c. **Public Consumption**

Expenditures in Producers' Prices

Public Housing and Services P.GPHS

$$P.GPHS = P.CRS70*0.105*\left(\frac{1316}{4340}\right)\left(\frac{1518}{1373}\right) - 0.104*TT70IOG$$

Non-productive Transport and Communication P.GNTC

$$P.GNTC = P.CRS70*0.161*\left(\frac{1438}{7380}\right)\left(\frac{1648}{1353}\right) - 0.133*TT70IOG$$

Health, Education, and Culture P.GHEC

$$P.GHEC = P.CRS70*0.577*\left(\frac{6176}{22150}\right)\left(\frac{7405}{6938}\right) - 0.507*TT70IOG$$

Science, Banking and Administration Outlays P.GSBA

$$P.GSBA = (17*P.BAO/1000+99.27*P.BRD/1000)\left(\frac{3430}{9619}\right)\left(\frac{4027}{3287}\right) - 0.276*TT70IOG$$

Total	P.GIO	=	P.GPHS+P.GNTC+P.GHEC+P.GSBA

where CRS70 = Services Consumption, billions of 1970 rubles

BAO = Index (1970=100), Expenditures, Administration and Other

BRD = Index (1970=100), Expenditures, Research and Development

d. <u>Exports</u>

<div align="center">Measured in Current U.S. Dollars</div>

Raw Materials	P.ERM	= (ERMCM+EFUELDW+EOMDW+EOSC +ETCH+ECUBA+EUSW9)/1000
Machinery	P.EMM	= (EMACM+EMADW+EARMLDC9)/1000
Food	P.EFM	= (EGRCM+ECOCM+EGRDW+EFODW +0.7*EODW)/1000
Consumer Goods	P.ECM	= (ETLDC+0.3*EODW)/1000

<div align="center">Measured in 1970 Producers' Prices</div>

Raw Materials $\qquad$ P.ENPR $\quad$ = $P.ERM/(PREX9*PTX9/97)*\left(\dfrac{7000}{4736}\right)^{1}$

Machinery $\qquad$ P.EMPR $\quad$ = $P.EMM/(PREX9*PTX9/97)*\left(\dfrac{1856}{1351.1}\right)$

Food $\qquad$ P.EFPR $\quad$ = $P.EFM/(PREX9*PTX9/97)*\left(\dfrac{742}{815.6}\right)$

Consumer Goods $\qquad$ P.ECPR $\quad$ = $P.ECM/(PREX9*PTX9/97)*\left(\dfrac{758}{933.4}\right)$

where $\quad$ PREX9 $\quad$ = Ruble/dollar Exchange Rate
$\qquad\quad$ PTX9 $\quad\;$ = Index (1970=100), prices received for Soviet exports;

$\qquad\quad$ in millions of current dollars:
$\qquad\quad$ ERMCM $\quad$ = Exports of Raw Materials and Fuel to the CMEA
$\qquad\quad$ EFUELDW $\;$ = Exports of Fuel to the Developed West
$\qquad\quad$ EOMDW $\quad$ = Exports to Non-Fuel Raw Materials to the Developed West
$\qquad\quad$ EOSC $\qquad$ = Exports to Other Socialist Countries
$\qquad\quad$ ETCH $\qquad$ = Exports to China
$\qquad\quad$ ECUBA $\quad$ = Exports to Cuba
$\qquad\quad$ EUSW9 $\quad$ = Unspecified Exports to the World
$\qquad\quad$ EMACM $\quad$ = Machinery Exports to the CMEA
$\qquad\quad$ EMADW $\quad$ = Machinery Exports to the Developed West
$\qquad\quad$ EARMLDC9 = Arms Exports to LDC
$\qquad\quad$ EGRCM $\quad$ = Grain Exports to the CMEA
$\qquad\quad$ ECOCM $\quad$ = Non-Grain Food Exports to the CMEA
$\qquad\quad$ EODW $\qquad$ = Other Exports to the Developed West
$\qquad\quad$ ETLDC $\quad$ = Total Exports to the LDC

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[1] This last factor combines conversion from 1977 foreign trade rules to 1970 producers' prices and a small correction to reconcile with the base year column total.

e. **Imports**

Measured in Current U.S. Dollars

Raw Materials	P.MRM	$=$ (MRMCM+MRMDW+MTLDC+0.33*MOSC)/1000
Machinery	P.MMM	$=$ (MMACM+MMADW+0.4*MOSC)/1000
Non-Grain Food	P.MFM	$=$ (MFOCM+MCUBA+0.3*MTCH+MUSDW9 + MUSCM9)/1000
Consumer Goods	P.MCM	$=$ (MCOCM+MCODW+0.27*MOSC+0.7* MTCH)/1000

Measured in 1966 Purchasers' Prices

Raw Materials	P.MRPU	$=$ P.MRM/(PREX9*PTM9/94)*2672/2043
Machinery	P.MMPU	$=$ P.MMM/(PREX9*PTM9/94)*1683.7/2731.5
Non-Grain Food	P.MFPU	$=$ P.MFM/(PREX9*PTM9/94)*1790.8/1124.9
Consumer Goods	P.MCPU	$=$ P.MCM/(PREX9*PTM9/94)*4998.7/1209.3
Total	P.MPU	$=$ P.MRPU+P.MMPU+1.33*P.MFPU+P.MCPU

Measured in 1970 Producers' Prices

Raw Materials[1]

$$P.MRPR = (P.MRPU-P.MRPU/P.MPU*TT70IOM/0.9456) * \left(\frac{259}{2558}\right)$$

Machinery

$$P.MMPR = (P.MMPU-P.MMPU/P.MPU*TT70IOM/0.9456 * \left(\frac{1793}{1612}\right)$$

Non-Grain Food

$$P.MFPR = (P.MFPU-P.MFPU/P.MPU*TT70IOM/0.9456) * \left(\frac{1741}{1714.5}\right)$$

---

[1] The last factor in this, and the succeeding three equations, accounts both for inflation from 1966 producers' prices to 1970 producers' prices and a base year proportionality adjustment.

Consumer Goods   P.MCPR   (P.MCPU−P.MCPU/P.MPU*TT70IOM/ 0.9456)

$$* (\frac{4808}{4786})$$

Grain   P.MGPR   = (P.MGRDW/PWUS*.001)*103*

$$(\frac{798}{679})$$

where   MRMCM   = Imports of Raw Materials from CMEA
        MRMDW   = Imports of Raw Materials from the Developed West
        MTLDC   = Imports from LDC's, Total
        MOSC   = Imports from Other Socialist Countries, Total
        MFOCM   = Imports of Food from the CMEA
        MCUBA   = Imports from Cuba, Total
        MTCH   = Imports from China, Total
        MUSDW9   = Unspecified Imports from the CMEA
        MCOCM   = Imports of Consumers' Goods from the CMEA
        MCODW   = Imports of Consumers' Goods from the Developed West all in millions of current dollars
        PTM9   = Index (1970=100), Prices Paid for Soviet Imports
        PWUS   = U.S. Export Price of Wheat (dollars per metric ton)
        MGRDW   = Imports of Grain from the Developed West (current dollars)

f. Fixed Investment

Equipment   P.IM   = (P.IAM+(0.0679+0.0806*QLT50)*

$$P.INA)* (\frac{18500}{18278})$$

Construction   P.IC   = (0.93461−0.19126*(QSH68−QSH73)+
0.54929*QSH73+(−0.10578+
0.07016*(QSH68−QSH73)−0.16468*
QSH73)*QLT50+0.01352*Q67)*
P.ITOTAL

Capital Repair   P.IRIO   = .18611*P.ICR/1000

where   IAM   = Agricultural Investment, Equipment
        ITOTAL   = Total Fixed Investment
        INA   = Non-Agricultural Fixed Investment
        QLT50   = Long Time Trend
        Q67   = Dummy Variable for 1967
        QSH68,QSH73 = Dummy Shift Variables, 1968 and 1973
        ICR   = Index (1970=100), Capital Repair

E.   Other Final Demand Items: Inventory/Residual Equations

By utilizing relationships described in Section 6 over the sample

period, column totals (the Y_j) were obtained for the final demand columns

of the B matrix for each year (adjusted proportionately to match the totals

of the base year benchmark table). Applying coefficients of the base-year

B matrix to the vector of column totals, sectoral entries were generated

for the columns. These were summed across each sector and deducted from

the sectoral final demands shown in Guill's series of 18-sector tables

(Guill, 1978) to produce a residual for each sector (termed INV_i) which

corresponds to the other final demand item entries in each year. Base year

residuals are shown in Table A-7.1.

For most of the sectors, this item represents inventory change and

statistical discrepancies. That for the MBMW sector other final demand

includes military procurement. For agriculture, the entry includes additions

to livestock herds which is determined in the agricultural block of the

model. This component is therefore deducted before the residual category

is modeled. The construction and MBMW residuals also are special cases and

will be treated below.

Other than the cases of agriculture, construction, and MBMW the residual

item is assumed to be a combination of inventory change and statistical

discrepancies, which might be treated as a function of expected and actual

shipments or production. Setting aside the discrepancies, relatively simple

models could be used to specify relationships to explain the residuals.

For example, desired inventory stock (INVS*) at the end of a period could be

hypothesized to be a function of expected output in the next period. If

desired and actual stocks were equal at the beginning of a period, desired

TABLE A-7.1

DISAGGREGATION OF OTHER FINAL DEMAND ITEMS: 1966
(Millions of 1970 rubles, producers' prices)

Sector	Additions to Livestock Herds ADLVR	Inventory Change NIIO	Defense Procurement DPIO	Unfinished Construction & "Other Outlays" ΔUC
01 Metallury		-610		
02 Coal and Peat		131		
03 Oil		-279		
04 Gas		90		
05 Electric Power		0		
06 MBMW		0	6,638 [1]	
07 Chemicals		909		
08 Forest Products		224		
09 Pulp and Paper		0		
10 Construction Materials		263		
11 Soft Goods		1,005		
12 Processed Food		481		
13 Industry, N.E.C.		-385		
14 Construction		0		7,254 [2]
15 Agriculture	1,568	6,136		
16 Transport and Communications		998		
17 Distribution and Trade		710		
18 Other Branches		42		
TOTAL	1,568	9,715	6,638	7,254

[1] This entry is the entire final demand residual for MBMW. Some share of this residual should be allocated to inventory change when relating that column total to the GNP category.

[2] This is the entire residual for the construction sector. It represents change in unfinished construction (both as reported in the Soviet handbook and the portion carried on the books of construction organizations), losses and other construction outlays (such as site preparation) and possibly a military construction component of about 1 billion rubles.

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inventory change would be the difference between desired levels of inventory
at the beginning and end of the period, that is:

$$INVS* = \alpha X*_{+1} \qquad\qquad INVS*_{-1} = \alpha X* \, ,$$

$$INV* = INVS* - INVS*_{-1} = \alpha(X*_{+1} - X*) \, .$$

Expected output (X*) could be hypothesized to be a function of last period's

actual output, for instance, $X* = \gamma X_{-1}$

substituting,

$$INV* = \alpha\gamma(X - X_{-1}) \, .$$

There could also be unanticipated inventory change which reflects gaps

between expected and actual output during the period. For example, this

component could be hypothesized to be a function of the anticipation error

such that:

$$INV_u = -\delta(X - X*) = -\delta(X - \gamma X_{-1}) \, .$$

Therefore, total inventory change would be the sum of desired and unanticipated

inventory change:

$$INV_t = INV* + INV_u$$

$$= \alpha\gamma(X - X_{-1}) - \delta(X - \gamma X_{-1})$$

$$= \delta(\gamma - 1)X + \gamma(\alpha - \delta)(X - X_{-1}) \, .$$

This rationale, and that statistical discrepancies might be related to levels

and changes in outputs, formed a partial basis for specifications of equations

estimated to predict the other final demand entries for sectors 1-5, 7-11, 13,

and 16-18.   Because there are tendencies over time to reduce inventories in

relation to output, that is, to achieve greater efficiencies in use of inven-

tories, time trend terms were included in the equations. Their coefficients,

of course, also would reflect trends in sector statistical discrepancies.
Finally, 1967 dummy variables were needed for four sectors to adjust for
measurement problems in that year (cf. section A-3). Results are shown
in Table A-7.2.

For the processed foods sector (number 12), a slightly different
form was selected involving the expected rate of growth of sectoral output
and change in agricultural output:

$$INV12 = \underset{(-6.47)}{-10.49} + \underset{(5.46)}{0.1303 \cdot XIOPF} + \underset{(1.25)}{\left[\frac{XIOPF}{XIOPF(-1)}\right]^{6.900}}$$

$$+ \underset{(1.25)}{0.0768 \ (XIOAG - XIOAG(-1))} - \underset{(2.51)}{3.3490 \cdot Q69}$$

where

Q69 = dummy variable equal to unity in 1969 and zero in all other years

$\bar{R}^2$ = 0.800

DW = 1.80

The residual for 1969 is removed from the sample period by use of a dummy
variable; unknown influences caused an unduly large negative unexplained
residual in that year.

In the case of agriculture, the net additions to livestock are
removed from the residual, which is explained by the change in gross value
of output and weather variables.

$$RESID15 = \underset{(2.81)}{1.2514} + \underset{(4.15)}{0.2921 \cdot (XIOAG - XIOAG(-1))} - \underset{(8.49)}{8.5916 \cdot JPS9}$$

$$+ \underset{(2.76)}{3.2407 \cdot JPW9} - \underset{(-5.37)}{9.0452 \cdot Q75}$$

where

$\bar{R}^2$ = 0.920

DW = 2.80

Table A-7.2

ESTIMATED EQUATIONS FOR "OTHER FINAL DEMAND" ITEMS (INV), SECTORS 1-5, 7-11, 13, 16-18

$$INV_i = a_1 + a_2 * XIO_i + a_3 * (XIO_i - XIO_i(-1)) + a_4 \, QT50 + a_5 * Q67 + a_6 * Q69$$

SECTOR		a_1	a_2	a_3	a_4	a_5	a_6	$\overline{R}^2$	DW
Metallurgy	01	0.4141 (0.81)	-0.4150 (-2.30)	-	0.6434 (1.91)	-2.0628 (-2.52)	-	.972	2.59
Coal and Peat	02	-0.6962 (-1.27)	0.4518 (4.88)	-0.0763 (-3.34)	-0.1943 (-9.96)	0.3033 (-2.72)	-0.1205 (1.30)	.992	2.05
Oil	03	-0.7347 (-9.11)	0.0415 (3.72)	0.4873 (7.40)	-	-0.1254 (-1.25)	-	.958	1.65
Gas	04	0.2464 (3.22)	0.2706 (4.93)	-	-0.0249 (-4.21)	-	-	.699	0.68
Electric Power	05	1.1018 (7.67)	0.3961 (15.19)	-0.0261 (-1.22)	-0.2521 (-12.35)	-	-	.984	2.74
Chemicals	07	-0.8036 (-8.50)	0.1244 (23.99)	-	-	-	-	.983	1.79
Forest Products	08	2.9953 (9.05)	0.5530 (6.58)	-	-0.5958 (-10.15)	-	-	.965	1.93
Paper and Pulp	09	-0.0577 (-1.08)	0.3563 (12.70)	-0.1639 (-3.54)	-0.0317 (-5.23)	-		.986	2.13
Construction Material	10	0.9913 (17.13)	0.0216 (1.66)	-	-0.0588 (-4.79)	-	-	.973	2.14
Soft Goods	11	3.9836 (3.21)	0.3943 (4.89)	-0.1761 (-1.28)	-1.1517 (-4.40)	0.8968 (1.27)	-	.679	2.67
Industry, NEC	13	2.5419 (9.14)	0.8139 (12.94)	-	-0.4878 (-14.24)	-	-	.953	1.99
Transport and Communication	16	1.5343 (6.90)	0.2606 (4.08)	0.1234 (3.09)	-0.2151 (-4.08)	-	-	.823	1.78
Trade and Distribution	17	0.2606 (0.56)	0.1272 (0.63)	0.3923 (2.70)	-0.1550 (-0.73)	-	-	.545	1.19
Other Branches	18	-2.0847 (-3.18)	1.3678 (6.81)	-0.3172 (-1.86)	-0.1777 (-26.99)	-	-	.990	1.65

Where INV_i = other final demand items, sector i

XIO_i = gross value of output, sector i

QT50 = time trend

Q67, Q69 = dummies for 1967, 1969

t-statistics appear in parentheses

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$$INV15 = RESID15 + ADLVR$$

where JPS9 = Sum of deviations from monthly precipitation value

JPW9 = Winter precipitation index

Q75 = Dummy for 1975

ADLVR = Net additions to livestock herds

The two weather indexes are used in the agricultural block of the model to explain deviations from normal agricultural output. Here they can be seen to represent the source of unintended inventory accumulation (decumulation) in the agricultural sector. The 1975 dummy represents, as it does in the agricultural block, a deviation from normal behavior that is not explained by the weather. This is most likely associated with organizational failures in the supply of materials and services to the sector (transportation, spare parts, etc.).

The construction residual includes change in unfinished construction, losses, and "other construction outlays" such as for ground preparation, etc., as well as change in stock of work in progress and other items on the books of construction organizations. The change in unfinished construction as reflected in the series in the Soviet handbooks and the "other" component are explained separately and removed from the residual. The residual is then explained by the change in gross value of construction output and a time trend with shifts provided for in the slope and inter-cept due to apparent changes in price regimes.

change in unfinished construction

$$UNFINC = 3.5226 + 4.7863*(QSH68 - QSH73) - 1.2129 * (XIOCM$$
$$(3.56) \quad (5.69) \quad\quad\quad (-1.53)$$
$$-XIOCM\ (-1)) - 1.1473*JPW9 + 2.7417*QSH73 - 1.7600*QFYP$$
$$(-1.23) \quad\quad (2.48) \quad\quad (-2.26)$$

$$\bar{R}^2 = .747 \quad DW = 1.79$$

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QSH68, QSH73 = Shift Dummies for 1968, 1973

QFYP = Dummy for effect of five year plan cycles on project completion

This specification primarily reflects the changing relationships between the volume of project starts and project completions. The change in output of construction materials reflects both changes in planned demand and actual availability of materials. The five-year dummy variable represents campaigns to complete ongoing projects before undertaking start-ups, usually associated with the end of one plan-period and spilling over into the beginning of the next. The weather variables reflect delays in the construction process due to adverse climatic conditions in the winter of various years.

Other Construction Outlays

$$OTHERCON = 2.1757 + 0.1035*XIOCN + 0.1887*QFYP$$
$$\qquad\qquad (-14.25) \quad (43.11) \qquad\quad (2.48)$$

$$\bar{R}^2 = .993 \quad DW = 1.19$$

Other construction outlays are explained by the level of construction work and the plan cycle.

Construction Residual

$$RESID14 = -0.6874 + 19.8469*(QSH68 - QSH73) + (0.3757 + 1.0867$$
$$\qquad\quad (-1.24) \qquad (3.38) \qquad\qquad\qquad\qquad\quad (2.79) \qquad (2.22)$$

$$*(QSH68 - QSH73))*(XIOCN - XIOCN (-1)) - 1.3477$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (-4.77)$$

$$*QSH68*QT50 + 2.4096 * Q73$$
$$\qquad\qquad\qquad\quad (2.03)$$

$$\bar{R}^2 = .931 \qquad DW = 2.43$$

where

        XIOCN = Gross Value of Output of Construction

          Q73 = Dummy for 1973

Other dinal Demand Items, Construction

        INV14 = UNFINC + OTHERCON + RESID14

The residual for Sector 6, Machine-building and metalworking is hypothesized to contain military procurement of durables. As data for this component, a series developed by Professor Stanley Cohn for military durables procurement from machiney production and sales data was used (see Table A-7.3).[1]

Military Durables is now an analyst determined target:

$$MDMIDPD = EXP\ (DELRAMD + ZETAMD + QT50 + LOG(ETAMD));$$

It is not adjusted by the balancing system; it is a firm target. The remaining Sector 6 residual is determined in an equation similar to the other sectoral INV equations with the addition of first and second-order autoregressive terms.

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[1] Stanley H. Cohn, Estimation of Military Durables Procurement Expenditures from Machinery Production and Sales Data, SRI Informal Note SSC-IN-78-13, September, 1978, p. 16 (column (2) O.E.R. series). These are in current rubles. Treml's MBMW price index was used to convert them to 1970 rubles.

Table A-7.3
Disaggregation of MBMW

Other Final Demand Items
(Billions of 1970 Rubles)

	Other Final Demand Items MBMW INVO6	Midpoint, COHN Procurement Series 1970 Prices MDMIDPD	Residual RESIDO6
1961	2.365	5.0	-2.64
1962	4.524	6.1	-1.58
1963	6.753	5.5	1.25
1964	6.623	6.3	.32
1965	5.815	6.5	-.68
1966	6.634	6.1	.53
1967	8.948	7.1	1.85
1968	14.136	9.0	5.14
1969	14.975	8.8	6.18
1970	12.607	10.0	2.61
1971	12.030	12.3	-.27
1972	12.468	13.1	-.63
1973	18.042	17.3	.74
1974	20.211	17.2	3.01
1975	20.725	19.8	.925

$$RESID06 = -1.8209 + 0.2681 *(XIOMB - XIOMB(-1)) + 1.0356$$
$$(-2.49) \qquad (3.32) \qquad\qquad\qquad (6.45)$$
$$* RESID06(-1) - 0.4784 * RESID06 (-2) + 3.1648 * Q68$$
$$(-3.17) \qquad\qquad\qquad (3.10)$$

$\bar{R}^2 = .883 \quad DW = 2.65$

And thus:

$$INV06 = MDMIDPD + RESID06$$

F.   Reconciliation of Model NMP and Input-Output Concepts

The model predicts a net material product (NMP) concept from the sector-of-origin side which excludes nonproductive services that do not enter into the Soviet national income account. This concept (model variable GNMP) can be reconciled with the input-output based concepts defined for the final demand matrix column totals. Such reconciliation not only helps to provide better understanding of the consistency of sector-of-origin and expenditure accounts, but also allows for the possibility of predicting net material and gross national product (GNP) from the demand-expenditure rather than the supply-production side.

For this purpose the model's detailed end-use categories adjusted for turnover taxes (those related to columns of the final demand matrix—see section 5) were summed for each year. (Proportionality adjustments should not be and were not applied). The sum is final expenditures (NMP-based) except for inventory change, defense procurement, and statistical discrepancy items. That is:

$$\text{NMPEXC} = \text{CGIO*} + \text{GSBA*} + \text{IM} + \text{IC} + \text{IRIO} + \text{ERPR*} + \text{EMPR*} +$$
$$\text{EFPR*} + \text{ECPR*} - \text{MIO*}$$

where

CGIO* = public and private consumption, unadjusted
           CIO + GPHS + GNTC + GHEC

GSBA* = state consumption, unadjusted expenditures on science,
           banking, and administration

IM = fixed investment, equipment

IC = fixed investment, construction

IRIO = capital repair

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ERPR*, EMPR*, EFPR*, ECPR* = exports, unadjusted

MIO* = imports, unadjusted

To relate this sum to the NMP measure in the model, the latter must be adjusted so that they correspond conceptually. NMP in the model contains turnover taxes and is net of depreciation while the above expenditure variables and those in the final demand matrix are gross of productive depreciation and measured in producers' prices. Thus, the residual of the model's transformed NMP and the above expenditures can be written as:

$$NMPRES = GNMP - 0.718 * TT + AMOR - NMPEXC$$

where

TT = turnover taxes (the 0.718 coefficient reflects the proportion of these taxes passed through to final demand)

AMOR = productive depreciation (amortization deductions)

Similarly, there is an unexplained residual of total final demand in the B flow matrixes over time:

sum of final expenditure items (except "other"):

$$FEXC = CIO + GIO + IM + IC + IRIO + ERPR + EMPR + EFPR$$
$$+ ECPR - MIO$$

total final demand:

$$G = \Sigma_i \text{ Final Demand}_i$$

final demand residual:

$$FRES = G - FEXC$$

See Table A-8.1 for these data.

These two sets of residuals are then related in a stochastic equation which allows for a shift in price regimes in 1969 and contains a dummy

variable for 1973. Note that the additions to livestock component is
removed from both residuals.

$$\text{NMPRES} - \text{ADLVR} = 4.0824 + 0.2604 * (\text{FRES} - \text{ADLVR}) - 3.7805$$
$$\qquad\qquad (1.64) \qquad (2.44) \qquad\qquad\qquad\quad (-4.76)$$
$$* \text{QSH69} + 2.4622 * \text{Q73}$$
$$\qquad\qquad\qquad (1.35)$$

$$\bar{R}^2 = .702 \qquad \text{DW} = 1.08$$

where

QSH69 = Shift variable for 1969 on

Q73 = Dummy variable for 1973

This relationship could be used with other equations of the model
expenditure-final demand linkage to permit NMP expenditure determination.
That is, with hats denoting model solution predicted values,

$$\hat{\text{NMP}} = \hat{\text{NMPEXC}} + \hat{\text{NMPRES}}$$

where

$\hat{\text{NMPRES}}$ is predicted by the stochastic equation with $\hat{\text{FRES}}$
$= \sum_i \text{INV}_i$ (i=1,18 sectors).

Table A. 8-1

Reconciliation of Net Material Product
and Final Demand Concepts
Billions of 1970 Rubles (except where indicated)

	(1) Net Material Product GNMP	(2) Turnover* Taxes TT	(3) Amortization* Deductions NMOR	(4) Total Final Demand C	(5) Total Final Expenditures Except Residual NMPEXC	(6) Final Demand Except Residual FEXC	(1)-.718(2) & (3)-(5) Model Residual NMPRES	(4)-(6) Final Demand Residual FRES
1962	178.516	32.9	11.300	170.947	158.298	150.369	7.893	20.578
1963	177.268	34.5	15.553	171.778	163.976	155.171	4.074	16.607
1963	194.445	36.7	17.045	185.771	172.664	162.934	12.476	22.837
1965	208.233	38.7	18.805	202.873	186.899	176.404	12.352	26.468
1966	222.284	39.3	20.584	216.001	202.404	191.030	12.246	24.971
1967	233.963	40.1	22.380	224.283	218.574	205.773	8.977	18.511
1968	248.260	40.8	24.357	247.416	233.038	219.577	10.285	27.838
1969	255.620	44.5	26.551	250.376	245.227	230.372	4.993	20.004
1970	278.266	49.4	29.105	277.791	261.668	245.587	10.234	32.203
1971	290.601	54.5	32.08	286.609	274.707	257.345	8.843	29.264
1972	295.883	55.6	35.291	289.154	285.914	267.678	5.339	21.476
1973	320.234	59.1	38.923	322.3.5	302.754	284.270	13.969	38.095
1974	333.09	63.5	42.741	332.298	318.971	299.223	11.267	33.075
1975	340.846	66.6	49.931	337.290	335.701	314.823	7.257	22.468

*Billions of current rubles

APPENDIX II

SEMREC3 SYMBOL DECLARATIONS
AND EQUATION LIST

EQS	Function
1-91	Definitions, Miscellaneous
92-139	Labor Allocation
140-157	Agriculture Block
158-161	Output Indices
162-188	Investment Block (branches & sectors)
189-214	Capital Stock EQS
215-278,422-423	Wage, Price, Government Revenue
279-329	Foreign Trade Block
330-333,424	Consumption Block
334-337	Aggregate Identities
338-402,425-429	Energy Block
403-415	Production Block
416-421	Investment Block (aggregates)
430-445	Linking Equations
446-497	Final Demand Definitions
498-528	Other Final Demand Components
529-546	Uses of Sectoral Outputs
547-564	Sources of Outputs for Final Expenditures
565-577	Balances
578-614	Adjustment Equations
615-650	Translation of Adjusted Final Demands into Model Categories

:MODEL: CURRENT

ENDOGENOUS:
ADLVP AFEED70 ALV ALVR70 AVCP70 BAD BAO BDT BDT70 BF BGN
BNAUK BPD BRES BRESID06 BSC BTRAN CDPR CFPR CNPR CRD70 CRF70
CPND70 CRS70 CR70 CSPR ECOCM ECFR ECUBA EFEECO EFEEGA EFEEDI
EFODW EFPR EFRWCO EFRWGA EFRWDI EFTEP EFUELDW EGRCM EGRDW EMACM
EMADW EMPR ENETCM ENETDW ENETGR ENFDW ENFRMCM EODW EOMDW EOSC
EPEECO EPEEGA EPEEDI ERMCM EPPR ETAIAC ETAIAM ETAINA ETAMD ETCH
ETCM ETDW ETLDC ETW ETW70 FCREP FDEBT FDHC FDSP FGOLDD FGOLDT
FINT FNETHC FSTK GEUSUM GHEC GNMP GNP GNPA GNPNA GNTC GPHS
GSBA HFTOT IA IAC IAM IC ICR ICRUB IHS IICH IICM IICP IIEP
IIFM IIFP IIMB IIN IINF IIPF IIPP IISG IM INA INV01 INV02
INV03 INV04 INV05 INV07 INV08 INV09 INV10 INV11 INV12 INV13
INV15 INV17 INV18 IRID ISER IS70NTA IS70T ITOTAL ITRUB I70NTA
I70T KAIR KAUTO KCOM KCR KELPC KELTETS KELTPC KHA KHBF KIA
KICH KICHW KICM KICP KIEP KIFM KIFP KIMB KIMBM KIPF KIPP
KIPPM KISG KITOT KIW KNEWOI KREPOI KSER KSUMOLD KTA KTCUS KTP
L01 L02 L03 L04 L06 L07 L08 L09 L10 L11 L12 L14 L15 MCOCM
MCODW MCPR MCUBA MDMIDPD MFOCM MFPR MGPR MGPDW MIECH MM9CM
MM9ADW MMPR MN9GDW MOSC MRMCM MPMDW MRPR MTCH MTCM MTDW MTLDC
MTM1005 MTM1209 MTW MTW70 NAKOL NAPPV NASOV NAT NIET NMC NMF
NMG NMI NMICH NMICM NMICP NMIEP NMIFP NMIMB NMIME NMINC NMIPA
NMIPF NMIPP NMISG NMNA NMO NMPRES NMS NMTC NPOPR NPOPU NTSPA
OTHERCON P.BAD P.BRD P.CRD70 P.CRF70 P.CPND70 P.CRS70 P.CR70
P.ETW P.ETW70 P.IA P.IAC P.IAM P.ICR P.INA P.ITOTAL P.MTW
P.MTW70 P.NAT P.NMC P.NMF P.NMG P.NMICH P.NMICM P.NMICP P.NMIEP
P.NMIFP P.NMIMB P.NMIME P.NMINC P.NMIPA P.NMIPF P.NMIPP P.NMISG
P.NMO P.NMS P.NMTC P.XIDAG P.XIDCH P.XIDCM P.XIDCN P.XIDCP
P.XIDFP P.XIDGA P.XIDMB P.XIDME P.XIONC P.XIDOB P.XIDDI P.XIDPA
P.XIDPF P.XIDSG PAFC70 PCD70 PFCC PGNP PIA PIC PIHS PII PIRF70
PIS PIT PJWL70 PNF70 PRC RESID06 RESID14 RESID15 TAXES TDP
TDSS TPOP TR TSI TT UCD UCOBF UCOKE UCOMF UCONT UCOXELTP
UELAG UELCN UELHHM UELIN UELOSS UELTR UF UFBF UFDIRECT UFLPPNT
UFLPPT UFMF UFSK UFT UFXELTP UGA UGABF UGANT UGAXELTP UHPP
ULPP ULPPMF UNFINC UPPBF UPPNT UPPXELTP UTPHHM UTPIND UTPLOSS
UTPTOT WAGA WAGCH WAGCM WAGCON WAGCP WAGE WAGEP WAGFM WAGFP
WASMB WAGPA WAGPF WAGSG WAGTC WAGTD WAK WAS WC WGS WI WS WTC
XACM XAGDV XAGSUM XAGTN XAGT70 XAM XAN XANIM70 XCROP70 XELAP
XELHP XELP XELTP XGR XGRPK XGRT XGPTN XIDAG XIDCH XIDCM XIDCN
XIDCP XIDDT XIDEP XIDFP XIDGA XIDMB XIDME XIONC XIDOB XIDDI
XIDPA XIDPF XIDSG XIDTC XMEAT70 XOCH XOCM XOCN XOCP XODT XDEP
XOFP XOIN XOMB XOME XOPA XOPF XOPP XOSG XOSV XOTC XTCOP
XTCOPEU XTGAN XTGANEU XTOIP XTOIPEU XTPTETS ZDT ZD70 ZGW ZIK70
ZMPA ZPG ZSAG ZTD ZTG ZWK ZWUM

DEFINITION:
    B.INV11 B.INV12 B.INV17 CDPU CFPU CIO CNPU CRS70G CSPU D.BDN9
    D.BDN9XI D.BDSR9 D.IFTR9 D.WAK D.WI D.X D.XAGT70 D.XIH D.XILT
    D.Y D.ZPG DHWA1 DHWA2 DKITOT DKTP ECM EFM EFUELCM EFUELEE
    EFUELPW EMM EPRIND ERM FRES F01 F02 F03 F04 F05 F06 F07 F08
    F09 F10 F11 F12 F13 F14 F15 F16 F17 F18 G01 G02 G03 G04
    G05 G06 G07 G08 G09 G10 G11 G12 G13 G14 G15 G16 G17 G18
    INV06 INV14 INV15 MCM MCPU MFM MFPU MINPUTAG MINPUTCH MINPUTCM
    MINPUTCN MINPUTPP MINPUTMB MINPUTME MINPUTNC MINPUTOB MINPUTPA
    MINPUTPF MINPUTSG MINPUTTC MIO MMM MMPU MRM MRPU NASK NTNEC
    NTOTAL OUTPUTNT P.CDPR P.CDPU P.CFPR P.CFPU P.CNPR P.CNPU P.CPU
    P.CRS70G P.CSPP P.CSPU P.ECM P.ECPR P.EFM P.EFPR P.EMM P.EMPR
    P.ERM P.ERPR P.GHEC P.GID P.GNTC P.GPHS P.GSBA P.IC P.IM P.IRIO
    P.MCM P.MCPR P.MCPU P.MFM P.MFPR P.MFPU P.MGPR P.MMM P.MMPR
    P.MMPU P.MPU P.MPM P.MRPR P.MRPU P.TT70CD P.TT70CF P.TT70CN
    P.TT70CS RKNAIR RKNCOM RKNDC RKNDH RKNDI RKNDT RKNICH RKNICM
    RKNICP RKNIEP RKNIFM RKNIFP RKNIMB RKNIPF RKNIPP RKNISG RKNSEB
    RKN1AIR RKN1COM RKN1DC RKN1DH RKN1DI RKN1DT RKN1ICM RKN1ICP
    RKN1IEP RKN1IFM RKN1IFP RKN1IMB RKN1IPF RKN1IPP RKN1ISG RKN2AIR
    RKN2COM RKN2DH RKN2DI RKN2DT RKN2ICH RKN2ICM RKN2ICP RKN2IEP
    RKN2IFM RKN2IFP RKN2IMB RKN2IPF RKN2IPP RKN3COM RKN3DI RKN3ICH
    RKN3ICM RKN3ICP RKN3IEP RKN3IFM RKN3IPF RKN3IPP RKN3SER RKN4DI
    RKN4ICM RKN4IEP RKN4SEP RKN5IEP RKN5SEP TPRIND TT70 TT70ID
    TT70IDC TT70IDF TT70IDG TT70IDM UTPF WSUMI WSUMJ XOPPEU

EXOGENOUS:
    A.ADLVP A.AFEED7 A.AVCP70 A.BAD A.BF A.BGN A.BNAUK A.BRES A.BSC
    A.BTRAN A.ECOCM A.ECUBA A.EFEECO A.EFEEGA A.EFEEDI A.EFODW
    A.EFPWCO A.EFPWGA A.EFRWDI A.EFTEP A.EFUELD A.EGRCM A.EGRDW
    A.EMACM A.EMADW A.ENFDW A.ENFRMC A.EODW A.EOMDW A.EOSC A.EPEECO
    A.EPEEGA A.EPEEDI A.ERMCM A.ETCH A.E.DW A.ETLDC A.FCREP A.FDSR
    A.FINT A.FNETHC A.ICR A.ICRUB A.IHS A.IICH A.IICM A.IICP A.IIEP
    A.IIFM A.IIFP A.IIMB A.IIN A.IINF A.IIPF A.IIPP A.IISG A.ISER
    A.ITRUB A.I7ONT9 A.I7OT A.KAIR A.KCOM A.KCR A.KELPC A.KHA A.KHBF
    A.KIA A.KICH A.KICHW A.KICM A.KICP A.KIEP A.KIFM A.KIFP A.KIMB
    A.KIMFM A.KIPF A.KIPP A.KIPPM A.KISG A.KITOT A.KIW A.KNEWDI
    A.KREPDI A.KSEP A.KSUMOL A.KTA A.KTCUS A.KTR A.MCDCM A.MCDDW
    A.MCUBA A.MFDCM A.MIECH A.MMACM A.MMADW A.MOSC A.MRMCM A.MRMDW
    A.MTCH A.MTLDC A.MTM100 A.MTM120 A.NIET A.NTSPA A.PAFC70 A.PCD70
    A.PGNP A.PIA A.PIC A.PIHS A.PII A.PIRF70 A.PIS A.PIT A.PIWL70
    A.PNF70 A.TDP A.TOSS A.TPDP A.TSD A.TT A.UELCN A.UELHHM A.WAGA
    A.WAGCH A.WAGCM A.WAGCOM A.WAGCP A.WAGE A.WAGEP A.WAGFM A.WAGFP
    A.WAGMB A.WAGPA A.WAGPF A.WAGSG A.WAGTC A.WAGTD A.WAK A.WAS A.WC
    A.WGS A.WI A.WS A.WTC A.XACN A.XAGTN A.XAGT70 A.XAM A.XAN
    A.XANIM7 A.XCROP7 A.XGR A.XGRPK A.XGRT A.XGRTN A.XMEAT7 A.XDCP
    A.XOEP A.XOIN A.XOPP A.XOSV A.XTCOP A.XTGAN A.XTOIP A.ZDT A.ZGW

II-3

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A.ZIK70  A.ZPG  A.ZSAG  ASGR9  A0101  A0102  A0103  A0104  A0105  A0106
A0107  A0108  A0109  A0110  A0111  A0112  A0113  A0114  A0115  A0116
A0117  A0118  A0201  A0202  A0203  A0204  A0205  A0206  A0207  A0208
A0209  A0210  A0211  A0212  A0213  A0214  A0215  A0216  A0217  A0218
A0301  A0302  A0303  A0304  A0305  A0306  A0307  A0308  A0309  A0310
A0311  A0312  A0313  A0314  A0315  A0316  A0317  A0318  A0401  A0402
A0403  A0404  A0405  A0406  A0407  A0408  A0409  A0410  A0411  A0412
A0413  A0414  A0415  A0416  A0417  A0418  A0501  A0502  A0503  A0504
A0505  A0506  A0507  A0508  A0509  A0510  A0511  A0512  A0513  A0514
A0515  A0516  A0517  A0518  A0601  A0602  A0603  A0604  A0605  A0606
A0607  A0608  A0609  A0610  A0611  A0612  A0613  A0614  A0615  A0616
A0617  A0618  A0701  A0702  A0703  A0704  A0705  A0706  A0707  A0708
A0709  A0710  A0711  A0712  A0713  A0714  A0715  A0716  A0717  A0718
A0801  A0802  A0803  A0804  A0805  A0806  A0807  A0808  A0809  A0810
A0811  A0812  A0813  A0814  A0815  A0816  A0817  A0818  A0901  A0902
A0903  A0904  A0905  A0906  A0907  A0908  A0909  A0910  A0911  A0912
A0913  A0914  A0915  A0916  A0917  A0918  A1001  A1002  A1003  A1004
A1005  A1006  A1007  A1008  A1009  A1010  A1011  A1012  A1013  A1014
A1015  A1016  A1017  A1018  A1101  A1102  A1103  A1104  A1105  A1106
A1107  A1108  A1109  A1110  A1111  A1112  A1113  A1114  A1115  A1116
A1117  A1118  A1201  A1202  A1203  A1204  A1205  A1206  A1207  A1208
A1209  A1210  A1211  A1212  A1213  A1214  A1215  A1216  A1217  A1218
A1301  A1302  A1303  A1304  A1305  A1306  A1307  A1308  A1309  A1310
A1311  A1312  A1313  A1314  A1315  A1316  A1317  A1318  A1401  A1402
A1403  A1404  A1405  A1406  A1407  A1408  A1409  A1410  A1411  A1412
A1413  A1414  A1415  A1416  A1417  A1418  A1501  A1502  A1503  A1504
A1505  A1506  A1507  A1508  A1509  A1510  A1511  A1512  A1513  A1514
A1515  A1516  A1517  A1518  A1601  A1602  A1603  A1604  A1605  A1606
A1607  A1608  A1609  A1610  A1611  A1612  A1613  A1614  A1615  A1616
A1617  A1618  A1701  A1702  A1703  A1704  A1705  A1706  A1707  A1708
A1709  A1710  A1711  A1712  A1713  A1714  A1715  A1716  A1717  A1718
A1801  A1802  A1803  A1804  A1805  A1806  A1807  A1808  A1809  A1810
A1811  A1812  A1813  A1814  A1815  A1816  A1817  A1818  BDN9  BDR9
BDCR9  BD9  BETAD  BETAF  BETAND  BETAS  CMCDE9  CMCOT9  CMGAE9  CMGAT9
CMPPE9  CMPPT9  DBAF  DELNMD9  DELTAIAC  DELTAIAM  DELTAINA  DELTAMD
DKAIP  DKCOM  DKCP  DKHBF  DKIA  DKICH  DKICM  DKICP  DKIEP  DKIFM
DKIFP  DKIMB  DKIPF  DKIPP  DKISG  DKSER  DKTR  EARMLDC9  EGRLDC9  EPEP
EPPWCD  EPPWGA  EPPWDI  EUSCM9  EUSW9  FCDR9  FGSALE  FSER9  GAMMAD
GAMMAF  GAMMAND  GAMMAS  HPTGA  IFTR9  IOTABAD  IOTABFD  IPPDRLD9  IRA9
IRCH9  IRCM9  IRCP9  IPEP9  IRFM9  IRFP9  IRIC9  IRIH9  IRII9  IRIS9
IPIT9  IRMP9  IRNF9  IRPF9  IPPP9  IRSG9  JPS9  JPW9  JTW9  KAPPA1
KAPPA10  KAPPA11  KAPPA12  KAPPA13  KAPPA14  KAPPA15  KAPPA16  KAPPA17
KAPPA18  KAPPA19  KAPPA2  KAPPA20  KAPPA21  KAPPA22  KAPPA23  KAPPA24
KAPPA25  KAPPA26  KAPPA27  KAPPA28  KAPPA29  KAPPA3  KAPPA4  KAPPA5
KAPPA6  KAPPA7  KAPPA8  KAPPA9  KELAPC9  KELHPC9  KIH629  KIT589  L05
```

```
L13  L16  L17  L18  L20  MIEIN  MUSCM9  MUSDW9  MU1  MU10  MU11  MU12
MU13  MU14  MU15  MU16  MU17  MU18  MU19  MU2  MU20  MU21  MU22  MU23
MU24  MU25  MU26  MU27  MU28  MU29  MU3  MU4  MU5  MU6  MU7  MU8  MU9
NEIND9  NETRA9  NHPIND  NMD9  NPOPAB9  NPOP9  NUBAO  NUBRD  NWE9
P.MSRDW  PETHUS9  PE1HUS9  PE2HUS9  PE3HUS9  PE4HUS9  PFUHUS9  PGOLD9
PGR9  PGVOAG  PGVOCH  PGVOCM  PGVOCN  PGVOFP  PGVOMB  PGVOME  PGVONC
PGVOOB  PGVOPA  PGVOPF  PGVOSG  PGVOTC  PIWH70  PM1DW9  PM1HUS9  PM2DW9
PM2HUS9  PM3DW9  PM3HUS9  PM4DW9  PM4HUS9  PREX9  PSI1  PSI10  PSI11
PSI12  PSI13  PSI14  PSI15  PSI16  PSI17  PSI18  PSI19  PSI2  PSI20
PSI21  PSI22  PSI23  PSI24  PSI25  PSI26  PSI27  PSI28  PSI29  PSI3
PSI4  PSI5  PSI6  PSI7  PSI8  PSI9  PSUGSU9  PTMEGTC9  PTM9  PTX9  PWUS
PXCON9  P71GE9  QDSRT  QFYP  QLIM  QLT28  QLT50  QPL5  QPR67  QQLT28
QQT50  Q3465  QSH67  QSH68  Q3H68SH  QSH69  QSH71  QSH71SH  QSH72  QSH73
QT50  QWREF  05959  05860  Q61  Q6162  Q6164  Q6165  Q62  Q63  Q6465
Q6467  Q65  Q6567  Q66  Q6668  Q6672  Q67  Q67SH  Q6769  Q6770  Q68
Q6869  Q6870  Q69  Q690N  Q70  Q7173  Q73  Q7374  Q74  Q75  Q7576  RHO1
RHO10  RHO11  RHO12  RHO13  RHO14  RHO15  RHO16  RHO17  RHO18  RHO19
RHO2  RHO20  RHO21  RHO22  RHO23  RHO24  RHO25  RHO26  RHO27  RHO28
RHO29  RHO3  RHO4  RHO5  RHO6  RHO7  RHO8  RHO9  RHRLE9  RXTGAN  RXTOIP
SIGMABAO  SIGMABRD  TAU1  TAU10  TAU11  TAU12  TAU13  TAU14  TAU15
TAU16  TAU17  TAU18  TAU19  TAU2  TAU20  TAU21  TAU22  TAU23  TAU24
TAU25  TAU26  TAU27  TAU28  TAU29  TAU3  TAU4  TAU5  TAU6  TAU7  TAU8
TAU9  TAX9  TDUES9  TINS29  UGAFSK9  UHPPFSK9  UHPPMF9  ULPPFSK9  WGVOAG
WGVOCH  WGVOCM  WGVOCN  WGVOFP  WGVOMB  WGVOME  WGVONC  WGVOOB  WGVOPA
WGVOPF  WGVOSG  WGVOTC  WTLDC9  XELPCTL9  XGOLDT9  XGRCM9  XGRWE9  XSUG9
XTPSEC9  YCMEA9  ZETAIAC  ZETAIAM  ZETAINA  ZETAMD  ZPCP9  ZWAIP79  Z01
Z06  Z07  Z08  Z09  Z10  Z11  Z12  Z14  Z15  Z20  Z22  Z23  Z24
```

MODEL: CURRENT

```
1:        MINPUTNC == (A0113+A0213+A0313+A0413+A0513+A0613+A0713+A0813+
          A0913+A1013+A1113+A1213+A1313+A1413+A1513+A1613+A1713+A1813)•
          XIONC

2:        MINPUTOB == (A0118+A0218+A0318+A0418+A0518+A0618+A0718+A0818+
          A0918+A1018+A1118+A1218+A1318+A1418+A1518+A1618+A1718+A1818)•
          XIOOB

3:        MINPUTAG == (A0115+A0215+A0315+A0415+A0515+A0615+A0715+A0815+
          A0915+A1015+A1115+A1215+A1315+A1415+A1515+A1615+A1715+A1815)•
          XIOAG

4:        MINPUTME == (A0101+A0201+A0301+A0401+A0501+A0601+A0701+A0801+
          A0901+A1001+A1101+A1201+A1301+A1401+A1501+A1601+A1701+A1801)•
          XIOME

5:        MINPUTMB == (A0106+A0206+A0306+A0406+A0506+A0606+A0706+A0806+
          A0906+A1006+A1106+A1206+A1306+A1406+A1506+A1606+A1706+A1806)•
          XIOMB

6:        MINPUTCH == (A0107+A0207+A0307+A0407+A0507+A0607+A0707+A0807+
          A0907+A1007+A1107+A1207+A1307+A1407+A1507+A1607+A1707+A1807)•
          XIOCH

7:        MINPUTFP == (A0108+A0208+A0308+A0408+A0508+A0608+A0708+A0808+
          A0908+A1008+A1108+A1208+A1308+A1408+A1508+A1608+A1708+A1808)•
          XIOFP

8:        MINPUTPA == (A0109+A0209+A0309+A0409+A0509+A0609+A0709+A0809+
          A0909+A1009+A1109+A1209+A1309+A1409+A1509+A1609+A1709+A1809)•
          XIOPA

9:        MINPUTCM == (A0110+A0210+A0310+A0410+A0510+A0610+A0710+A0810+
          A0910+A1010+A1110+A1210+A1310+A1410+A1510+A1610+A1710+A1810)•
          XIOCM

10:       MINPUTSG == (A0111+A0211+A0311+A0411+A0511+A0611+A0711+A0811+
          A0911+A1011+A1111+A1211+A1311+A1411+A1511+A1611+A1711+A1811)•
          XIOSG

11:       MINPUTPF == (A0112+A0212+A0312+A0412+A0512+A0612+A0712+A0812+
          A0912+A1012+A1112+A1212+A1312+A1412+A1512+A1612+A1712+A1812)•
          XIOPF

12:       MINPUTCN == (A0114+A0214+A0314+A0414+A0514+A0614+A0714+A0814+
          A0914+A1014+A1114+A1214+A1314+A1414+A1514+A1614+A1714+A1814)•
          XIOCN
```

```
13:     MINPUTTC == (A0116+A0216+A0316+A0416+A0516+A0616+A0716+A0816+
        A0916+A1016+A1116+A1216+A1316+A1416+A1516+A1616+A1716+A1816)*
        XIOTC

14:     DKITOT == (DKICH*KICH+DKICM*KICM+DKICP*KICP+DKIEP*KIEP+DKIFM*
        KIFM+DKIFP*KIFP+DKIMB*KIMB+DKIPF*KIPF+DKIPP*KIPP+DKISG*KISG)/
        KITOT

15:     RKNDI == IF DKITOT GT 0 THEN 1-DBAR*DKITOT ELSE 0

16:     RKNAIR == IF DKAIR GT 0 THEN 1-DBAR*DKAIR ELSE 0

17:     RKNIPF == IF DKIPF GT 0 THEN 1-DBAR*DKIPF ELSE 0

18:     RKNISG == IF DKISG GT 0 THEN 1-DBAR*DKISG ELSE 0

19:     RKNIPP == IF DKIPP GT 0 THEN 1-DBAR*DKIPP ELSE 0

20:     RKNICM == IF DKICM GT 0 THEN 1-DBAR*DKICM ELSE 0

21:     RKNIFP == IF DKIFP GT 0 THEN 1-DBAR*DKIFP ELSE 0

22:     RKNIMB == IF DKIMB GT 0 THEN 1-DBAR*DKIMB ELSE 0

23:     RKNICH == IF DKICH GT 0 THEN 1-DBAR*DKICH ELSE 0

24:     RKNIFM == IF DKIFM GT 0 THEN 1-DBAR*DKIFM ELSE 0

25:     RKNICP == IF DKICP GT 0 THEN 1-DBAR*DKICP ELSE 0

26:     RKNIEP == IF DKIEP GT 0 THEN 1-DBAR*DKIEP ELSE 0

27:     RKNSER == IF DKSER GT 0 THEN 1-DBAR*DKSER ELSE 0

28:     RKNDH == IF DKHBF GT 0 THEN 1-DBAR*DKHBF ELSE 0

29:     RKNCOM == IF DKCOM GT 0 THEN 1-DBAR*DKCOM ELSE 0

30:     RKNDT == IF DKTR GT 0 THEN 1-DBAR*DKTR ELSE 0

31:     RKNDC == IF DKCR GT 0 THEN 1-DBAR*DKCR ELSE 0

32:     NTNEC == P.NMC+P.NMTC+P.NMS+P.NMG+P.NMIEP+P.NMICP+P.NMIPP+
        P.NMIME+P.NMICH+P.NMIMB+P.NMIFP+P.NMICM+P.NMISG+P.NMIPF+P.NMF
        +P.NMO+P.NMIPA+P.NMINC+1000.*P.NAT
```

```
33:     RKN1IPF == IF RKNIPF(-1) GT 0 THEN RKNIPF(-1) ELSE 1

34:     RKN2IPF == IF SUM(I = -2 TO -1 : RKNIPF(I)) GT 0 THEN (1-DBAR
        (-2)*DKIPF(-2))*(1-DBAR(-1)*DKIPF(-1)) ELSE 1

35:     RKN3IPF == IF SUM(I = -3 TO -1 : RKNIPF(I)) GT 0 THEN (1-DBAR
        (-3)*DKIPF(-3))*(1-DBAR(-2)*DKIPF(-2))*(1-DBAR(-1)*DKIPF(-1))
        ELSE 1

36:     RKN1ISG == IF RKNISG(-1) GT 0 THEN RKNISG(-1) ELSE 1

37:     RKN1ICM == IF RKNICM(-1) GT 0 THEN RKNICM(-1) ELSE 1

38:     RKN2ICM == IF SUM(I = -2 TO -1 : RKNICM(I)) GT 0 THEN (1-DBAR
        (-2)*DKICM(-2))*(1-DBAR(-1)*DKICM(-1)) ELSE 1

39:     RKN3ICM == IF SUM(I = -3 TO -1 : RKNICM(I)) GT 0 THEN (1-DBAR
        (-3)*DKICM(-3))*(1-DBAR(-2)*DKICM(-2))*(1-DBAR(-1)*DKICM(-1))
        ELSE 1

40:     RKN4ICM == IF SUM(I = -4 TO -1 : RKNICM(I)) GT 0 THEN (1-DBAR
        (-4)*DKICM(-4))*(1-DBAR(-3)*DKICM(-3))*(1-DBAR(-2)*DKICM(-2))
        *(1-DBAR(-1)*DKICM(-1)) ELSE 1

41:     RKN1IFP == IF RKNIFP(-1) GT 0 THEN RKNIFP(-1) ELSE 1

42:     RKN2IFP == IF SUM(I = -2 TO -1 : RKNIFP(I)) GT 0 THEN (1-DBAR
        (-2)*DKIFP(-2))*(1-DBAR(-1)*DKIFP(-1)) ELSE 1

43:     RKN1IMB == IF RKNIMB(-1) GT 0 THEN RKNIMB(-1) ELSE 1

44:     RKN2IMB == IF SUM(I = -2 TO -1 : RKNIMB(I)) GT 0 THEN (1-DBAR
        (-2)*DKIMB(-2))*(1-DBAR(-1)*DKIMB(-1)) ELSE 1

45:     RKN2ICH == IF SUM(I = -2 TO -1 : RKNICH(I)) GT 0 THEN (1-DBAR
        (-2)*DKICH(-2))*(1-DBAR(-1)*DKICH(-1)) ELSE 1

46:     RKN3ICH == IF SUM(I = -3 TO -1 : RKNICH(I)) GT 0 THEN (1-DBAR
        (-3)*DKICH(-3))*(1-DBAR(-2)*DKICH(-2))*(1-DBAR(-1)*DKICH(-1))
        ELSE 1

47:     RKN1IFM == IF RKNIFM(-1) GT 0 THEN RKNIFM(-1) ELSE 1

48:     RKN2IFM == IF SUM(I = -2 TO -1 : RKNIFM(I)) GT 0 THEN (1-DBAR
        (-2)*DKIFM(-2))*(1-DBAR(-1)*DKIFM(-1)) ELSE 1
```

```
49:     RKN3IFM == IF SUM(I = -3 TO -1 : RKNIFM(I)) GT 0 THEN (1-DBAR
        (-3)◆DKIFM(-3))◆(1-DBAR(-2)◆DKIFM(-2))◆(1-DBAP(-1)◆DKIFM(-1))
        ELSE 1

50:     RKN1ICP == IF RKNICP(-1) GT 0 THEN RKNICP(-1) ELSE 1

51:     RKN2ICP == IF SUM(I = -2 TO -1 : RKNICP(I)) GT 0 THEN (1-DBAR
        (-2)◆DKICP(-2))◆(1-DBAR(-1)◆DKICP(-1)) ELSE 1

52:     RKN3ICP == IF SUM(I = -3 TO -1 : RKNICP(I)) GT 0 THEN (1-DBAR
        (-3)◆DKICP(-3))◆(1-DBAR(-2)◆DKICP(-2))◆(1-DBAR(-1)◆DKICP(-1))
        ELSE 1

53:     RKN1IPP == IF RKNIPP(-1) GT 0 THEN RKNIPP(-1) ELSE 1

54:     RKN2IPP == IF SUM(I = -2 TO -1 : RKNIPP(I)) GT 0 THEN (1-DBAR
        (-2)◆DKIPP(-2))◆(1-DBAR(-1)◆DKIPP(-1)) ELSE 1

55:     RKN3IPP == IF SUM(I = -3 TO -1 : PKNIPP(I)) GT 0 THEN (1-DBAR
        (-3)◆DKIPP(-3))◆(1-DBAR(-2)◆DKIPP(-2))◆(1-DBAR(-1)◆DKIPP(-1))
        ELSE 1

56:     RKN1IEP == IF PKNIEP(-1) GT 0 THEN RKNIEP(-1) ELSE 1

57:     PKN2IEP == IF SUM(I = -2 TO -1 : RKNIEP(I)) GT 0 THEN (1-DBAR
        (-2)◆DKIEP(-2))◆(1-DBAR(-1)◆DKIEP(-1)) ELSE 1

58:     RKN3IEP == IF SUM(I = -3 TO -1 : PKNIEP(I)) GT 0 THEN (1-DBAP
        (-3)◆DKIEP(-3))◆(1-DBAR(-2)◆DKIEP(-2))◆(1-DBAR(-1)◆DKIEP(-1))
        ELSE 1

59:     RKN4IEP == IF SUM(I = -4 TO -1 : PKNIEP(I)) GT 0 THEN (1-DBAR
        (-4)◆DKIEP(-4))◆(1-DBAR(-3)◆DKIEP(-3))◆(1-DBAR(-2)◆DKIEP(-2))
        ◆(1-DBAR(-1)◆DKIEP(-1)) ELSE 1

60:     RKN5IEP == IF SUM(I = -5 TO -1 : RKNIEP(I)) GT 0 THEN (1-DBAR
        (-5)◆DKIEP(-5))◆(1-DBAR(-4)◆DKIEP(-4))◆(1-DBAR(-3)◆DKIEP(-3))
        ◆(1-DBAR(-2)◆DKIEP(-2))◆(1-DBAR(-1)◆DKIEP(-1)) ELSE 1

61:     RKN1AIR == IF RKNAIR(-1) GT 0 THEN RKNAIR(-1) ELSE 1

62:     RKN2AIR == IF SUM(I = -2 TO -1 : RKNAIR(I)) GT 0 THEN (1-DBAR
        (-2)◆DKAIR(-2))◆(1-DBAR(-1)◆DKAIR(-1)) ELSE 1

63:     RKN3SER == IF SUM(I = -3 TO -1 : RKNSER) GT 0 THEN (1-DBAR(-3
        )◆DKSER(-3))◆(1-DBAR(-2)◆DKSER(-2))◆(1-DBAR(-1)◆DKSER(-1))
        ELSE 1
```

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64:     RKN4SER == IF SUM(I = -4 TO -1 : RKNSER(I)) GT 0 THEN (1-DBAR
        (-4)*DKSER(-4)*(1-DBAR(-3)*DKSER(-3))*(1-DBAR(-2)*DKSER(-2))
        *(1-DBAR(-1)*DKSER(-1)) ELSE 1

65:     RKN5SER == IF SUM(I = -5 TO -1 : RKNSER(I)) GT 0 THEN (1-DBAR
        (-5)*DKSER(-5)*(1-DBAR(-4)*DKSER(-4))*(1-DBAR(-3)*DKSER(-3))
        *(1-DBAR(-2)*DKSER(-2))*(1-DBAR(-1)*DKSER(-1)) ELSE 1

66:     RKN1DH == IF RKNDH(-1) GT 0 THEN RKNDH(-1) ELSE 1

67:     RKN2DH == IF SUM(I = -2 TO -1 : RKNDH(I)) GT 0 THEN (1-DBAR(
        -2)*DKHBF(-2))*(1-DBAR(-1)*DKHBF(-1)) ELSE 1

68:     RKN1COM == IF RKNCOM(-1) GT 0 THEN RKNCOM(-1) ELSE 1

69:     RKN2COM == IF SUM(I = -2 TO -1 : RKNCOM(I)) GT 0 THEN (1-DBAR
        (-2)*DKCOM(-2))*(1-DBAR(-1)*DKCOM(-1)) ELSE 1

70:     RKN3COM == IF SUM(I = -3 TO -1 : RKNCOM(I)) GT 0 THEN (1-DBAR
        (-3)*DKCOM(-3))*(1-DBAR(-2)*DKCOM(-2))*(1-DBAR(-1)*DKCOM(-1))
        ELSE 1

71:     RKN1DT == IF RKNDT(-1) GT 0 THEN RKNDT(-1) ELSE 1

72:     RKN2DT == IF SUM(I = -2 TO -1 : RKNDT(I)) GT 0 THEN (1-DBAR(
        -2)*DKTR(-2))*(1-DBAR(-1)*DKTR(-1)) ELSE 1

73:     RKN1DC == IF RKNDC(-1) GT 0 THEN RKNDC(-1) ELSE 1

74:     RKN1DI == IF RKNDI(-1) GT 0 THEN RKNDI(-1) ELSE 1

75:     RKN2DI == IF SUM(I = -2 TO -1 : RKNDI(I)) GT 0 THEN (1-DBAR(
        -2)*DKITOT(-2))*(1-DBAR(-1)*DKITOT(-1)) ELSE 1

76:     RKN3DI == IF SUM(I = -3 TO -1 : RKNDI(I)) GT 0 THEN (1-DBAR(
        -3)*DKITOT(-3))*(1-DBAR(-2)*DKITOT(-2))*(1-DBAR(-1)*DKITOT(-1
        )) ELSE 1

77:     RKN4DI == IF SUM(I = -4 TO -1 : RKNDI(I)) GT 0 THEN (1-DBAR(
        -4)*DKITOT(-4))*(1-DBAR(-3)*DKITOT(-3))*(1-DBAR(-2)*DKITOT(-2
        ))*(1-DBAR(-1)*DKITOT(-1)) ELSE 1

78:     NTOTAL == NPART9*NPOPAB9*1000.

79:     WSUMI == 1/(2*(A01/W01**2+A02/W02**2+A03/W03**2+A04/W04**2+
        A06/W06**2+A07/W07**2+A08/W08**2+A09/W09**2+A10/W10**2+A11/
        W11**2+A12/W12**2+A13/W13**2+A14/W14**2+A15/W15**2+A16/W16**2
        +A17/W17**2+A18/W18**2))
```

80: WSUMI == 20.685/(2*(A21/WW21**2+A22/WW22**2+A23/WW23**2+A24/
WW24**2+A25/WW25**2+A26/WW26**2+A27/WW27**2+A28/WW28**2+A29/
WW29**2+A30/WW30**2+A31/WW31**2+A32/WW32**2+A33/WW33**2+A34/
WW34**2+A35/WW35**2+A36/WW36**2+A37/WW37**2+A38/WW38**2+A39/
WW39**2+A40/WW40**2))

81: EFUELEE == MU29*((EFEECO*EPEECO+EFEEDI*EPEEDI+EFEEGA*EPEEGA)*
PREX9/1000)+KAPPA29*EXP(PSI29+RHO29*QT50+TAU29)

82: EFUELCM == (EFEEDI*EPEEDI+EFEECO*EPEECO+EFEEGA*EPEEGA+EFTEP*
EPEP)*PREX9/1000

83: EFUELPW == (EFRWDI*EPRWDI+EFRWCO*EPRWCO+EFRWGA*EPRWGA)*PREX9/
1000

84: D.ZPG == ZPG/PII(-1)/(ZPG(-1)/PII(-2))-1.

85: D.BDN9 == BDN9/PIWH70/(BDN9(-1)/PIWH70(-1))-1.

86: D.BDSR9 == BDSR9/XDMB+BDSR9(-1)/XDMB(-1)

87: D.IFTR9 == IFTR9/PIT(-1)/(IFTR9(-1)/PIT(-2))-1.

88: D.XAGT70 == XAGT70-XAGTN+(XAGT70(-1)-XAGTN(-1))

89: D.WAK == 10.*(WAK/PRC(-1))/(XAGT70(-1)/NAT(-1))

90: D.WI == (C645+C646*QSH68+C298*(1.-QSH68)*(QT50-C301))*(WI*NMI
/(C297*XDIN))

91: D.BDN9XI == 100.*BDN9/PIWH70/(C949*XDIN)

92: NPOPU = NPOP9-NPOPR

93: NPOPR = NAT*2.7

94: NMN9 = NMI+NMC+NMTC+NMS+NMG+NMF+NMD

95: NMI = NMIEP+NMICP+NMIPP+NMIME+NMICM+NMICH+NMIMB+NMIFP+NMIPA+
NMISG+NMIPF+NMINC

96: P.NMG = RNKG9*KSER

97: P.NMD = RNKD9*P.NAT

98: NASOV = SSOV9*NAT

99: P.NMF = RNKF9*P.NAT

100: NAKOL = SKOL9*NAT

```
101:      NAPRV = NAT-NASDV-NAKOL

102:      NASK == NASDV+NAKOL

103:      LOG(P.NAT) = 1/(WGVDAG*C3AG)*LOG(0.5*(XIDAG+P.XIDAG))-(1-
          WGVDAG-PGVDAG)/WGVDAG*LOG(KAIR)-PGVDAG/WGVDAG*LOG(MINPUTAG)-
          C1AG/(WGVDAG*C3AG)-LOG(NHRIND)-C4AG/(WGVDAG*C3AG)*LOG(ASGP9)-
          C5AG/(WGVDAG*C3AG)*JPS9-C6AG/(WGVDAG*C3AG)*JTW9-C7AG/(WGVDAG*
          C3AG)*075

104:      P.NMICP = RNKCP9*KICP

105:      P.NMIPP = RNKPP9*KIPP

106:      LOG(P.NMIME) = 1/(WGVDME*C3ME)*LOG(XIDME)-(1-WGVDME-PGVDME)/
          WGVDME*LOG(1.5*KIFM)-PGVDME/WGVDME*LOG(MINPUTME)-C1ME/(WGVDME
          *C3ME)-LOG(NHRIND)

107:      LOG(P.NMIMB) = 1/(WGVDMB*C3MB)*LOG(XIDMB)-(1-WGVDMB-PGVDMB)/
          WGVDMB*LOG(KIMB)-PGVDMB/WGVDMB*LOG(MINPUTMB)-C1MB/(WGVDMB*
          C3MB)-LOG(NHRIND)

108:      LOG(P.NMICH) = 1/(WGVDCH*C3CH)*LOG(XIDCH)-(1-WGVDCH-PGVDCH)/
          WGVDCH*LOG(KICH)-PGVDCH/WGVDCH*LOG(MINPUTCH)-C1CH/(WGVDCH*
          C3CH)-LOG(NHRIND)

109:      P.NMIEP = RNKEP9*KIEP

110:      LOG(P.NMIFP) = 1/(WGVDFP*C3FP)*LOG(XIDFP)-(1-WGVDFP-PGVDFP)/
          WGVDFP*LOG(KIFP)-PGVDFP/WGVDFP*LOG(MINPUTFP)-C1FP/(WGVDFP*
          C3FP)-LOG(NHRIND)

111:      LOG(P.NMIPA) = 1/(WGVDPA*C3PA)*LOG(XIDPA)-(1-WGVDPA-PGVDPA)/
          WGVDPA*LOG(KIFP)-PGVDPA/WGVDPA*LOG(MINPUTPA)-C1PA/(WGVDPA*
          C3PA)-LOG(NHRIND)

112:      LOG(P.NMICM) = 1/(WGVDCM*C3CM)*LOG(XIDCM)-(1-WGVDCM-PGVDCM)/
          WGVDCM*LOG(KICM)-PGVDCM/WGVDCM*LOG(MINPUTCM)-C1CM/(WGVDCM*
          C3CM)-LOG(NHRIND)

113:      LOG(P.NMIPF) = 1/(C3PF*WGVDPF)*LOG(0.5*(XIDPF+P.XIDPF))-
          PGVDPF/WGVDPF*LOG(MINPUTPF)-(1-WGVDPF-PGVDPF)/WGVDPF*LOG(KIPF
          )-C1PF/(C3PF*WGVDPF)-LOG(NHRIND)

114:      P.NMISG = RNKSG9*KISG

115:      P.NMINC = RNKNC9*P.NMICM

116:      LOG(P.NMC) = 1/(WGVDCN*C3CN)*LOG(0.5*(XIDCN+P.XIDCN))-(1-
          WGVDCN-PGVDCN)/WGVDCN*LOG(KCR)-PGVDCN/WGVDCN*LOG(MINPUTCN)-
          C1CN/(WGVDCN*C3CN)-LOG(NHRIND)
```

117: $LOG(P.NMTC) = 1/(WGVOTC \cdot C3TC) \cdot LOG(XIOTC) - (1-WGVOTC-FGVOTC)/$
      $WGVOTC \cdot LOG(KTR) - FGVOTC/WGVOTC \cdot LOG(MINPUTTC) - C1TC/(WGVOTC \cdot C3TC$
      $) - LOG(NHPIMD)$

118: $P.NMS = RNKS9 \cdot KCOM$

119: $NMC = P.NMC \cdot NTOTAL/NTNEC$

120: $NMTC = P.NMTC \cdot NTOTAL/NTNEC$

121: $NMS = P.NMS \cdot NTOTAL/NTNEC$

122: $NMG = P.NMG \cdot NTOTAL/NTNEC$

123: $NMIEP = P.NMIEP \cdot NTOTAL/NTNEC$

124: $NMICP = P.NMICP \cdot NTOTAL/NTNEC$

125: $NMIPP = P.NMIPP \cdot NTOTAL/NTNEC$

126: $NMIME = P.NMIME \cdot NTOTAL/NTNEC$

127: $NMICH = P.NMICH \cdot NTOTAL/NTNEC$

128: $NMIMB = P.NMIMB \cdot NTOTAL/NTNEC$

129: $NMIPF = P.NMIPF \cdot NTOTAL/NTNEC$

130: $NMIFP = P.NMIFP \cdot NTOTAL/NTNEC$

131: $NMICM = P.NMICM \cdot NTOTAL/NTNEC$

132: $NMISG = P.NMISG \cdot NTOTAL/NTNEC$

133: $NMF = P.NMF \cdot NTOTAL/NTNEC$

134: $NMO = P.NMO \cdot NTOTAL/NTNEC$

135: $NMIPA = P.NMIPA \cdot NTOTAL/NTNEC$

136: $NMINC = P.NMINC \cdot NTOTAL/NTNEC$

137: $NAT = P.NAT \cdot NTOTAL/NTNEC - DELNMD9$

138: $NIET-A.NIET-NIET(-1) = C97 \cdot ((NEIND9+NEIND9(-1)+NEIND9(-2))/3.$
      $)+C98 \cdot 969DN+C99 \cdot (2. \cdot (NIET(-1)-NIET(-2))/(NEIND9(-1)+NEIND9(-2$
      $))+C100)$

139: $NTSPA-A.NTSPA-NTSPA(-1) = C101 \cdot ((NETPA9(-1)+NETPA9(-2))/2.)+$
      $C102 \cdot (2. \cdot (NTSPA(-1)-NTSPA(-2))/(NETRA9(-1)+NETRA9(-2))+C103)$

140: $LOG(XAGTN-A.XAGTN)-C666 \cdot LOG(NAT)-C667 \cdot LOG(ALV)-C667 \cdot LOG($
      $AVCP70) = C668+C669 \cdot LOG(KAIR)+C670 \cdot LOG(A3GP9)$

141:    LOG(XAGT70-A.XAGT70)-LOG(XAGTN) = C835+C836*JPS9+C853*JTW9+
    C854*075

142:    LOG(XACN-A.XACN)-C666*LOG(NAT)-C855*LOG(ASGR9) = C856+C857*
    LOG(XAIR)+C587*LOG(AVCP70)

143:    LOG(XCROP70-A.XCROP7)-LOG(XACN) = C858+C859*JPS9+C898*075+
    C889*JTW9+C990*JPW9

144:    LOG(XAN-A.XAN) = C891+C892*LOG(ALV)+C893*(AFEED70/ALV)

145:    LOG(XANIM70-A.XANIM7)-LOG(XAN) = C894+C895*(XGRT/XGRTN-1.)

146:    LOG(XAM-A.XAM) = C896+C897*LOG(ALV)+C898*(AFEED70/ALV)

147:    LOG(XMEAT70-A.XMEAT7)-LOG(XAM) = C899+C660*(XCROP70/XACN-1.)+
    C661*06465

148:    LOG(XGRTN-A.XGRTN)-C666*LOG((NASK+NASK(-1)+NASK(-2))/3.)-C855
    *LOG(AVCP70) = C662+C663*LOG(ASGR9)+C664*LOG(XAIR)

149:    LOG(XGRT-A.XGRT)-LOG(XGRTN) = C665+C637*JPS9+C638*JTW9+C639*
    065+C640*075

150:    LOG(XGRPK-A.XGRPK) = C642+C641*LOG(XGRTN)+C643*LOG(ASGR9)

151:    LOG(XGR-A.XGR) = C582+C581*LOG(XGRT)+C583*JPS9+C584*LOG(ASGR9
)

152:    100.*(AVCP70-A.AVCP70)/XACN = C585+C586*XDCH(-1)/XACN

153:    (AFEED70-A.AFEED7)/ALV = C1000+C1003*(XCROP70/XACN+XCROP70(-1
)/XACN(-1)-2.)+C1004*00LT28+C1001*065

154:    ALVR70 = IF DRIPF(-1) GT 0 THEN 0.9*(ALVR70(-1)+ADLVR(-1))
    ELSE ALVR70(-1)+ADLVR(-1)

155:    (ADLVR-A.ADLVR)/ALVR70+0.05 = C1005+C1006*(0LT28+C1010)*0SH72
    +C1007*(AFEED70/ALVR70)+C1008*(XCROP70/XACN-1.)+C1002*06768

156:    ALV = ALVR70+0.5*ADLVR

157:    XAGDV = XAGT70/XAGTN-1.

158:    XDIN-A.XDIN = (C440*XDEP+C442*XDPP+C441*XDCP+(C336+C443)*XDME
    +C800*XDCH+C802*XDMB+C806*XDPP+C813*XDPA+C354*XDCM+C814*XDSG+
    C816*XDPF)/C817

159:    XDEP-A.XDEP = C526A+C527A*XELP+C528A*0LT50

160:    XDPP-A.XDPP = (0.6093*XTOIP/353.039+0.3907*XTGAN/197945.)*
    100.

161: $LOG(XDSV-A.XDSV) = C866+C867*(C868*LOG(NMG)+C869*LOG(KHBF+KSER))+C1044*OLIM$

162: $IIN-A.IIN = IRII9*INA$

163: $ICRUB-A.ICRUB = IRIC9*INA$

164: $ITRUB-A.ITRUB = IRIT9*INA$

165: $IHS-A.IHS = IRIH9*INA$

166: $ISER-A.ISER = IRIS9*INA$

167: $P.IA = P.IAM+P.IAC$

168: $IIEP-A.IIEP = IREP9*IIN$

169: $IICP-A.IICP = IRCP9*IIN$

170: $IIPP-A.IIPP = IRPP9*IIN$

171: $IIFM-A.IIFM = IRFM9*IIN$

172: $IINF-A.IINF = IRNF9*IIN$

173: $IICH-A.IICH = IRCH9*IIN$

174: $IIMB-A.IIMB = IRMB9*IIN$

175: $IIFP-A.IIFP = IRFP9*IIN$

176: $IICM-A.IICM = IRCM9*IIN$

177: $IICG-A.IICG = IRCG9*IIN$

178: $IIPF-A.IIPF = IRPF9*IIN$

179: $D.X == 0.25951*XDIG+0.26044*XDPF$

180: $D.Y == 1.57119*IDIN-D.X$

181: $D.XILT == D.X(-1)*(0.1*D.X(-1)/D.X(-2)+0.4*D.X(-2)/D.X(-3)+0.4*D.X(-3)/D.X(-4)+0.1*D.X(-4)/D.X(-5))$

182: $D.XIH == D.Y(-1)*(0.1*D.Y(-1)/D.Y(-2)+0.4*D.Y(-2)/D.Y(-3)+0.4*D.Y(-3)/D.Y(-4)+0.1*D.Y(-4)/D.Y(-5))$

183: $I70T-A.I70T = C675+C676*IS70T(-1)+C677*D.XILT+C678*(D.X-CRND70-CPD70)+C680*(XAGT70(-1)-XAGTN(-1))+C681*(100.*BDN9/PIWH70-100.*BDN9(-1)/PIWH70(-1)-C682)$

184: $IS70T = IS70T(-1)+I70T$

185:    I70NTA-A.I70NTA = C684+C685*IS70NTA(-1)+C686*D.XIH+C687*(
D.XIH-D.Y-C688)+C689*O66

186:    IS70NTA = IS70NTA(-1)+I70NTA

187:    100.*(P.ICP-A.ICP)/KSUMOLD = C654+C655*(QT50-22.)*O3H71+C233*
O62+C335*O6870(-1)

188:    P.ITOTAL = P.INA+P.IAM+P.IAC

189:    KITOT-A.KITOT = (1-DBAR(-1)*DKITOT(-1))*(KITOT(-1)-C104*KITOT
(-1))+C160*(QFVP(-1)-C478)+C161*RKN1DI*IIN(-1)+C162*RKN2DI*
IIN(-2)+C163*RKN3DI*IIN(-3)+C164*RKN4DI*IIN(-4)

190:    KIA-A.KIA = (1-DBAR(-1)*DKIA(-1))*(KITOT-KIT589(-1)-KIH629(-1
))

191:    KCP-A.KCP = (1-DBAR(-1)*DKCP(-1))*(KCP(-1)-C105*KCP(-1))+C165
*(QPL5(-1)-C479)+C166*RKN1DC*ICRUB(-1)

192:    KTP-A.KTP = (1-DBAR(-1)*DKTP(-1))*(KTP(-1)-C169*KTP(-1))+C167
*(O65(-1)-C444)+C169*RKN1DT*ITRUB(-1)+C168*(RKN2DT*ITRUB(-2))

193:    KTA-A.KTA = KTP+KIT589(-1)

194:    KTCUI-A.KTCUI = C170*O3H65+C171*O3H65*QT50+C172*(1.-O3H65)+
C173*(1.-O3H65)*QT50+C174*(BDNA*PIWH70-(BDNA(-1)*PIWH70(-1))-
1.)

195:    KCOM-A.KCOM = (1-DBAR(-1)*DKCOM(-1))*(KCOM(-1)-C178*KCOM(-1))
+C175*O65(-1)+C176*(O68(-1)-O68(-2))+C177*RKN2COM*IIEP(-2)+
C177*RKN3COM*IIEP(-3)

196:    KHEP-A.KHEP = (1-DBAR(-1)*DKHEP(-1))*(KHEP(-1)-C194*KHEP(-1))
+C180*O62(-1)+C181*RKN1DH*IHI(-1)+C181*RKN2DH*IHI(-2)

197:    KHA-A.KHA = KHEP+C840 C841*KIH629(-1)

198:    KIEP-A.KIEP = (1-DBAR(-1)*DKIEP(-1))*(KIEP(-1)-C182*KIEP(-1))
+C184*O63(-1)+C187*(O70(-1)-O70(-2))+C185*RKN4IEP*IIEP(-4)+
C185*RKN5IEP*IIEP(-5)

199:    KAIP-A.KAIP = (1-DBAR(-1)*DKAIP(-1))*(KAIP(-1)*(-C674+C189*
RKN1AIP*IA(-1)+C672*RKN3AIP*IA(-2)+C188*(O66(-1)+O67(-1)+
O65A(-1)))

200:    KIW-A.KIW = C194*KIW(-1)+C195*(MIEIN(-1)/(PPEX9(-1)*P71GE9(-1
)))

201: KIEP-A.KIEP = (1-DBAR(-1)◆DKIEP(-1))◆(KIEP(-1)-C199◆KIEP(-1))
+C190◆PKN1IEP◆IIEP(-1)+C191◆PKN2IEP◆IIEP(-2)+PKN3IEP◆C191◆
IIEP(-3)+C193◆PKN4IEP◆IIEP(-4)+C198◆PKN5IEP◆IIEP(-5)

202: KICP-A.KICP = (1-DBAR(-1)◆DKICP(-1))◆(KICP(-1)-C204◆KICP(-1))
+C201◆(OFYP(-1)-C478)+C202◆068(-1)+C203◆PKN1ICP◆IICP(-1)+C203
◆PKN2ICP◆IICP(-2)+C203◆PKN3ICP◆IICP(-3)

203: KIPP-A.KIPP = (1-DBAR(-1)◆DKIPP(-1))◆(KIPP(-1)-C208◆KIPP(-1))
+C207◆PKN1IPP◆IIPP(-1)+PKN2IPP◆IIPP(-2)+PKN3IPP◆IIPP(-3))

204: KIFM-A.KIFM = (1-DBAR(-1)◆DKIFM(-1))◆(KIFM(-1)-C193◆KIFM(-1))
+C192◆PKN1IFM◆IIFM(-1)+C192◆PKN2IFM◆IIFM(-2)+C192◆PKN3IFM◆
IIFM(-3)

205: KICH-A.KICH = (1-DBAR(-1)◆DKICH(-1))◆(KICH(-1)-C211◆KICH(-1))
+(+C209◆(OFYP(-1)-C478)+C210◆PKN3ICH◆IICH(-3)+C210◆PKN2ICH◆
IICH(-2)

206: KIME-A.KIME = (1-DBAR(-1)◆DKIME(-1))◆(+KIME(-1)-C215◆KIME(-1))
+C213◆(OFYP(-1)-C478)+C213◆(068(-1)-C299)+C214◆PKN1IME◆IIME(
-1)+C214◆PKN2IME◆IIME(-2)

207: KIFP-A.KIFP = (1-DBAR(-1)◆DKIFP(-1))◆(KIFP(-1)-C218◆KIFP(-1))
+C216◆(OFYP(-1)-C478)+C217◆PKN1IFP◆IIFP(-1)+C217◆PKN2IFP◆IIFP
(-2)

208: KICM-A.KICM = (1-DBAR(-1)◆DKICM(-1))◆(+KICM(-1)-C220◆KICM(-1))
+C219◆(070(-1)-C300)+C222◆PKN1ICM◆IICM(-1)+C223◆PKN2ICM◆IICM(
-2)+C224◆PKN3ICM◆IICM(-3)+C226◆PKN4ICM◆IICM(-4)

209: KIIG-A.KIIG = (1-DBAR(-1)◆DKIIG(-1))◆(+KIIG(-1)-C230◆KIIG(-1))
+C229◆PKN1IIG◆IIIG(-1)+C228◆(061(-1)-062(-1))

210: KIPF-A.KIPF = (1-DBAR(-1)◆DKIPF(-1))◆(+KIPF(-1)-C106◆KIPF(-1))
+C233◆(061(-1)-062(-1))+C236◆PKN1IPF◆IIPF(-1)+C234◆PKN2IPF◆
IIPF(-2)+C235◆PKN3IPF◆IIPF(-3)

211: KIUMOLD-A.KIUMOL = KAIP+0.5◆(2◆(+KHA+KCP+KIA+KCOM+KTA+KIEP(-
C10)+ITOT+C160◆(OFYP-C478)+C161◆IIN+C162◆PKN1DI◆IIN(-1)+C163
◆PKN2DI◆IIN(-2)+C164◆PKN3DI◆IIN(-3)-C105◆KCP+C165◆(OPLS-C479)
+C166◆ICPUB-C169◆KTR+C167◆(065-C444)+C168◆ITPUB+C168◆PKN1DT◆
ITPUB(-1)-C178◆KCOM+C175◆065+C176◆(068-068(-1))+C177◆PKN1COM◆
IIEP(-1)+C177◆PKN2COM◆IIEP(-2)-C184◆KHEP+C180◆062+C181◆IHC+
C181◆PKN1DH◆IHC(-1)-C192◆KSEP+C186◆063+C187◆(070-070(-1))+
C185◆PKN3IEP◆IIEP(-3)+C185◆PKN4IEP◆IIEP(-4))

212: KIPPM-A.KIPPM = C194◆KIPPM(-1)+C195◆(MTM1209(-1)/P71GE9(-1))

213: KICHW-A.KICHW = C194◆KICHW(-1)+C195◆(MIECH(-1)/(PPEX9(-1)◆
P71GE9(-1)))

214: KIMEM-A.KIMEM = C194◆KIMEM(-1)+C195◆(MTM1005(-1)/P71GE9(-1))

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215: $(WI-A.WI)/PRO(-1)/(C884 \cdot (XDIN/NMI))-WI(-1)/PRO(-2)/(C884 \cdot ($
$XDIN(-1)/NMI(-1))) = C454+C453 \cdot (C450-WI(-1)/PRO(-2)/(C884 \cdot ($
$XDIN(-1)/NMI(-1)))+C455 \cdot (QWREF-2. \cdot C457)+C456 \cdot (Q61-C457)+C458$
$\cdot (XAGT70-XAGTN+(XAGT70(-1)-XAGTN(-1)))$

216: $IHWA1 == C461+C462 \cdot (1.-QSH68) \cdot (QT50+C463)$

217: $10. \cdot ((WAS-A.WAS)/PRO(-1))/(XAGTN(-1)/NAT(-1))-10. \cdot (WAS(-1)/$
$PRO(-2))/(XAGTN(-2)/NAT(-2)) = C460+C459 \cdot (IHWA1-10. \cdot (WAS(-1)/$
$PRO(-2)/(XAGTN(-2)/NAT(-2)))$

218: $IHWA2 == C466+C467 \cdot (1.-QSH68) \cdot (QT50+C468)$

219: $10. \cdot ((WAK-A.WAK)/PRO(-1)/(XAGT70(-1)/NAT(-1)))-10. \cdot (WAK(-1)/$
$PRO(-2)/(XAGT70(-2)/NAT(-2))) = C465+C464 \cdot (IHWA2-10. \cdot WAK(-1)/$
$PRO(-2)/(XAGT70(-2)/NAT(-2)))$

220: $(WC-A.WC)/WI = C469+C470 \cdot (QT50+C471) \cdot (1.-Q690N)$

221: $(WTC-A.WTC)/WI = C472 \cdot WTC(-1)/WI(-1)+C473 \cdot (Q6162-2. \cdot C474)$

222: $(WGS-A.WGS)/WGS = C241 \cdot WGS(-1)/WGS(-1)+C242 \cdot (Q6668-3. \cdot C243)$

223: $(WGS-A.WGS)/WI = C244 \cdot WGS(-1)/WI(-1)+C245 \cdot Q65$

224: $(WAGE-A.WAGE)/WI = C252+C253 \cdot Q69+C254 \cdot QSH65$

225: $(WAGFM-A.WAGFM)/WI = C255+C256 \cdot (WAGFM(-1)/WI(-1)-1.)+C257 \cdot$
$QSH69SH$

226: $(WAGCP-A.WAGCP)/WI = C258+C259 \cdot QSH68SH$

227: $(WAGEP-A.WAGEP)/WI = C260+C261 \cdot (WAGEP(-1)/WI(-1)-1.)+C262 \cdot$
$QSH69SH$

228: $(WAGMB-A.WAGMB)/WI = C263+C264 \cdot (XDMB/NMIMB/(XDIN/NMI))+C265 \cdot ($
$WAGMB(-1)/WI(-1)-1.)$

229: $(WAGCH-A.WAGCH)/WI = C266+C267 \cdot QSH68SH$

230: $(WAGFP-A.WAGFP)/WI = C268+C269 \cdot QSH68SH$

231: $(WAGPA-A.WAGPA)/WI = C270+C271 \cdot (WAGPA(-1)/WI(-1)-1.)$

232: $(WAGCM-A.WAGCM)/WI = C272+C273 \cdot (WAGCM(-1)/WI(-1)-1.)+C274 \cdot$
$QSH68SH$

233: $(WAGSG-A.WAGSG)/WI = C275+C276 \cdot (WAGSG(-1)/WI(-1)-1.)$

234: $(WAGPF-A.WAGPF)/WI = C277+C278 \cdot (WAGPF(-1)/WI(-1)-1.)$

235: $(WAGCON-A.WAGCON)/WC = C247+C248*QSH65$

236: $WAGA-A.WAGA = C246*WA3$

237: $WAGTC-A.WAGTC = C249*WTC$

238: $WAGTD-A.WAGTD = C250*WS+C251*QSH68$

239: $ZGW-A.ZGW = C279*(NMI*WI+NMC*WC+NMTC*WTC+NMS*WS+NMG*WGS+1000.$
$*NA3DV*WA3)/1.000000E06$

240: $ZWK = NAKOL*(WAK/1000.)$

241: $LOG(ZSAG-A.ZSAG) = C280+C281*(LOG(PAFC70)+LOG(XAGT70))+C282*($
$XAGT70/XAGTN-1.)+C283*Q69$

242: $ZMPA = 3.32/3.535*NMD9$

243: $ZTG = ZGW+ZWK+ZSAG+BTRAN+ZPCP9$

244: $ZTD = ZTG-TAXES-TDUE39-TINJP9$

245: $ZIK70-A.ZIK70-ZIK70(-1) = C284+C285*(XAGT70/XAGTN-1.)+C286*($
$XAGT70(-1)/XAGTN(-1)-1.)$

246: $ZD70 = 100.*ZTD/PCD70+ZIK70+ZMPA$

247: $(ZPG-A.ZPG)/ZPG(-1) = C287+C288*Q6668+C289*Q70+C290*(XAGT70/$
$XAGTN-1)+C291*QSH65$

248: $(ZDT-A.ZDT)/ZDT(-1) = C292*(FJUMOLD+JUMOLD(-1))+C293*Q63+$
$C294*(QSH67-QSH67(-1))$

249: $PNF70-A.PNF70-PNF70(-1) = C295+C296*(D.WI-PNF70(-1))$

250: $PIPF70-A.PIPF70-PIPF70(-1) = C650+C651*(D.WI-PIPF70(-1))+C652$
$*(PAFC70-PAFC70(-2))$

251: $(PAFC70-A.PAFC70)/PAFC70(-1) = C992+C993*Q69+C998*MGPDW/(PGR9$
$*XGRTN)+C999*(XAGT70(-1)/XAGTN(-1)-1.)+C975*Q6567$

252: $PFCC = C976*PIPF70+C977*PAFC70$

253: $PFC = 0.6*PFCC+0.4*PNF70$

254: $PIWL70-A.PIWL70-PIWL70(-1) = C978+C979*Q67+C980*Q73+C981*($
$D.WI-PIWL70(-1))$

255: $PII-A.PII = C995*PXCDN9+C996*PIWH70$

256: $PIC-A.PIC = C997 \cdot PXCDN9+C940 \cdot PIWH70$

257: $PIT-A.PIT = C941 \cdot PXCDN9+C942 \cdot PIWH70$

258: $PIS-A.PIS = C943 \cdot PXCDN9+C944 \cdot PIWH70$

259: $PIHS-A.PIHS = C945 \cdot PXCDN9+C936 \cdot PIWH70$

260: $PIA-A.PIA = C937 \cdot PXCDN9+C938 \cdot PIWH70+C916$

261: $PGNP-A.PGNP = C917+C918 \cdot QT50+C919 \cdot QPR67+C885 \cdot XAGDV+C886 \cdot (XDIN / XDIN(-1)-1.)$

262: $PCD70-A.PCD70 = C656+C657 \cdot QT50+C658 \cdot (XAGT70/XAGTN-1.)+C601 \cdot (XAGT70(-1)/XAGTN(-1)-1.)$

263: $(TDP-A.TDP)/ZPG = C480+C481 \cdot (BD9/BGN+C482)+C483 \cdot QSH67$

264: $(TT-A.TT)/(ZGW+ZWK) = C879 \cdot QSH68SH+C880 \cdot QSH68+C486 \cdot (1-QSH68) \cdot QT50+C487 \cdot (PRC(-1)/PRC(-2)-1.)+C489 \cdot (BD9/BGN+C490)$

265: $(TOSS-A.TOSS)/ZPG = C491+C492 \cdot Q6165+C493 \cdot Q5860+C494 \cdot Q6672$

266: $(TSD-A.TSD)/(ZGW+ZWK) = C495+C496 \cdot Q6768$

267: $(TPOP-A.TPOP)/(ZGW+ZWK) = C497+C498 \cdot Q5959+C499 \cdot Q6467$

268: $TAXES = TPOP+TAX9$

269: $TR = TDP+TT+TOSS+TPOP$

270: $(BGN-A.BGN)/BGN(-1)-1. = C500 \cdot (TR/TR(-1)-1.)+C501 \cdot (TR/TR(-1)-1.) \cdot (TR(-1)-BGN(-1))$

271: $(BF-A.BF)/BF(-1)-1. = C502+C503 \cdot (BGN/BGN(-1)-1.)+C504 \cdot (BD9/BD9(-1)-1.)$

272: $(BSC-A.BSC)/BSC(-1)-1. = C506+C507 \cdot (WGS/WGS(-1)-1.)+C508 \cdot QSH71SH$

273: $(BAD-A.BAD)/BAD(-1)-1. = C509+C510 \cdot (WGS/WGS(-1)-1.)$

274: $(BNAUK-A.BNAUK)/BNAUK(-1)-1. = C511+C512 \cdot QT50$

275: $(BTRAN-A.BTRAN)/BTRAN(-1)-1. = C513+C514 \cdot (WGS/WGS(-1)-1.)+C515 \cdot (XGPT/XGPTN-1.)$

276: $BRES-A.BRES = BGN-(BF+BSC+BAD+BD9)$

277: $BDT = BD9+BDR9+BDSR9$

278:     $BDT70 = C521/C522 \cdot NMD9 + BDSR9 + 100. \cdot (BDN9/PIWH70) + BDP9/(0.2 \cdot ($
$WG9/C525) + 0.8 \cdot (PIWH70/100.))$

279:     $(ENFRMCM - A.ENFPMC)/PM2HUS9 = MU1 \cdot (-12.472 + 0.228 \cdot YCMEA9 + 6.834 \cdot$
$PFUHUS9) + KAPPA1/PM2HUS9 \cdot EXP(PSI1 + PHO1 \cdot QT50 + TAU1)$

280:     $EPMCM - A.ERMCM = ENFRMCM + EFUELEE$

281:     $(EMACM - A.EMACM)/PM1HUS9 = MU2 \cdot (C703 + C704 \cdot Q6870(-1) + C705 \cdot QFYP +$
$C706 \cdot YCMEA9 + C707 \cdot (ERMCM/PM2HUS9)) + KAPPA2/PM1HUS9 \cdot EXP(PSI2 +$
$RHO2 \cdot QT50 + TAU2)$

282:     $EGPCM - A.EGRCM = MU3 \cdot (C708 + C709 \cdot SUM(I = -3 \text{ TO } -1 : (XGRT(I) -$
$XGRTN(I))/XGRTN) + C1045 \cdot PGR9 + C1046 \cdot Q70(-1)) + KAPPA3 \cdot EXP(PSI3 +$
$PHO3 \cdot QT50 + TAU3)$

283:     $ECOCM - A.ECOCM = MU4 \cdot (C710 + C711 \cdot (2. \cdot XAGDV(-1) + XAGDV(-2))/3. +$
$C712 \cdot (0.25951 \cdot XDG6 + 0.26044 \cdot XDPF - CRND70 - CRD70) + C713 \cdot PM3HUS9) +$
$KAPPA4 \cdot EXP(PSI4 + RHO4 \cdot QT50 + TAU4)$

284:     $ETCM = EPMCM + EMACM + EGRCM + ECOCM + EUOCM9$

285:     $ENETCM = ETCM - MTCM$

286:     $(EFUELDW - A.EFUELD)/EFUELPW = MU5 \cdot (-0.244163 + 0.28072 \cdot QLT50) +$
$KAPPA5/EFUELPW \cdot EXP(PSI5 + PHO5 \cdot QT50 + TAU5)$

287:     $EMADW - A.EMADW = MU6 \cdot (C1047 + C1048 \cdot (FDEBT - FITF) + C1049 \cdot PM1HUS9/$
$PM1DW9) + KAPPA6 \cdot EXP(PSI6 + RHO6 \cdot QT50 + TAU6)$

288:     $EOMDW - A.EOMDW = MU7 \cdot (C766 + C793 \cdot PM2HUS9/PM2DW9 + C797 \cdot PTMEGTC9 +$
$C824 \cdot ZWAIP79) + KAPPA7 \cdot EXP(PSI7 + PHO7 \cdot QT50 + TAU7)$

289:     $EODW - A.EODW = MU8 \cdot (C1050 + C1051 \cdot PM4HUS9/PM4DW9 + C1052 \cdot ZWAIP79) +$
$KAPPA8 \cdot EXP(PSI8 + PHO8 \cdot QT50 + TAU8)$

290:     $ENFDW - A.ENFDW = EMADW + EFUELDW + EOMDW + EODW$

291:     $100. \cdot (EGRDW - A.EGRDW)/(PGR9 \cdot XGRTN) = MU9 \cdot (C723 \cdot Q1H72 + C724 \cdot ($
$XGRWE9/NWE9) \cdot Q0H72 + C730 \cdot (SUM(I = -3 \text{ TO } -1 : XGRT(I) - XGRTN(I))$
$/XGRTN) \cdot Q0H72) + 100 \cdot KAPPA9/(PGR9 \cdot XGRTN) \cdot EXP(PSI9 + RHO9 \cdot QT50 +$
$TAU9)$

292:     $EFODW - A.EFODW = MU10 \cdot (C731 + C732 \cdot 10. \cdot PM3DW9 + C733 \cdot XCRDP70(-1)) +$
$KAPPA10 \cdot EXP(PSI10 + PHO10 \cdot QT50 + TAU10)$

293:     $ETDW - A.ETDW = ENFDW + EGRDW + EFODW$

294:     $ENETGR = EGRCM + EGRDW + EGRLDC9 - MGRDW$

295:      ENETDW = ETDW-MTDW

296:      ETLDC-A.ETLDC = MU11◆(C734+C735◆WTLDC9+C736◆ETLDC(-1)+C737◆
          EARMLDC9)+KAPPA11◆EXP(PSI11+RHO11◆QT50+TAU11)

297:      EDSC-A.EDSC = MU13◆(C738+C739◆PETHU59+C439◆EDSC(-1)+C588◆
          WTLDC9)+KAPPA13◆EXP(PSI13+RHO13◆QT50+TAU13)

298:      ETCH-A.ETCH = MU12◆(C740+C741◆06770+C742◆QT50)+KAPPA12◆EXP(
          PSI12+RHO12◆QT50+TAU12)

299:      ECUBA-A.ECUBA = MU14◆(C743+C744◆ECUBA(-1)+C745◆PETHU59+C746◆
          06465+C1053◆WTLDC9)+KAPPA14◆EXP(PSI14+RHO14◆QT50+TAU14)

300:      F.ETW = ETDW+ETCM+ETCH+EDSC+ECUBA+ETLDC+EUSW9

TROLL COMMAND: .PRTMOD EQ 301 TO 400:

MODEL: CURRENT

301:      F.ETW70 = 1.5◆(100.◆F.ETW)/(PREX9◆PTX9)

302:      (MPMCM-A.MPMCM)/PE2HU59 = MU15◆(C747+C748◆(EPMCM◆PFUHU59)/
          PM2HU59+C749◆06870(-1))+KAPPA15/PE2HU59◆EXP(PSI15+RHO15◆QT50+
          TAU15)

303:      (MMACM-A.MMACM)/PE1HU59 = MU16◆(C750+C753◆EMACM/PM1HU59)+
          KAPPA16/PE1HU59◆EXP(PSI16+RHO16◆QT50+TAU16)

304:      (MFDCM-A.MFDCM)/PE3HU59 = MU17◆(C754+C755◆CRF70+C756◆(GFCM9+
          GFCM9(-1))+C757◆069+C758◆XAGDV+C759◆075)+KAPPA17/PE3HU59◆EXP
          (PSI17+RHO17◆QT50+TAU17)

305:      (MCDCM-A.MCDCM)/PE4HU59 = MU18◆(C760+C761◆MCDCM(-1)/PE4HU59(
          -1)+C762◆(CPD70+CPND70))+KAPPA18/PE4HU59◆EXP(PSI18+RHO18◆QT50
          +TAU18)

306:      MTCM = MPMCM+MMACM+MFDCM+MCDCM+MUCCM9

307:      100.◆(MMADW-A.MMADW)/(P71GE9(-1)◆IIN) = MU19◆(C763+C764◆(FDSP
          (-1)-ODSRT(-1))+C765◆07576)+100◆KAPPA19/(P71GE9(-1)◆IIN)◆EXP(
          PSI19+RHO19◆QT50+TAU19)

308:      (MPMDW-A.MPMDW)/PM2DW9 = MU20◆(C767+C768◆XDIN+C769◆(FDSP(-1)-
          ODSRT(-1)))+KAPPA20/PM2DW9◆EXP(PSI20+RHO20◆QT50+TAU20)

309:      (MCDDW-A.MCDDW)/PM4DW9 = MU21◆(C770+C771◆CR70+C772◆(FDSP(-1)-
          ODSRT(-1))+C773◆07173)+KAPPA21/PM4DW9◆EXP(PSI21+RHO21◆QT50+
          TAU21)

310:    MNGDW = MMADW+MRMDW+MCODW+MUSDW9

311:    MTDW = MNGDW+MGRDW

312:    MTLDC-A.MTLDC = MU22◆(C778+C779◆ETLDC+C780◆PM2DW9/PM1DW9+C781
        ◆MTLDC(-1))+KAPPA22◆EXP(PSI22+RHO22◆QT50+TAU22)

313:    MDSC-A.MDSC = MU23◆(C782+C783◆EDSC)+KAPPA23◆EXP(PSI23+RHO23◆
        QT50+TAU23)

314:    MTCH-A.MTCH = MU24◆(C784+C785◆ETCH+C786◆Q6164)+KAPPA24◆EXP(
        PSI24+RHO24◆QT50+TAU24)

315:    MCUBA-A.MCUBA = MU25◆(C787+C788◆(XSUG9◆PSUGSU9))+KAPPA25◆EXP(
        PSI25+RHO25◆QT50+TAU25)

316:    P.MTW = MTDW+MTCM+MTLDC+MDSC+MTCH+MCUBA

317:    P.MTW70 = 2.◆(100.◆F.MTW)/(PREX9◆PTM9)

318:    100.◆(MTM1005-A.MTM100)/(IIMB◆P71GE9(-1)) = MU26◆(C794+C795◆
        Q70+C796◆(FDSR(-1)-QDSRT(-1)))+100◆KAPPA26/(IIMB◆P71GE9(-1))◆
        EXP(PSI26+RHO26◆QT50+TAU26)

319:    100.◆(MTM1209-A.MTM120)/(IIPP◆P71GE9(-1)) = MU27◆(C798+C804◆
        QFYP+C808◆(FDSR(-1)-QDSRT(-1))+C809◆Q7374)+100◆KAPPA27/(IIPP◆
        P71GE9(-1))◆EXP(PSI27+RHO27◆QT50+TAU27)

320:    100.◆(MIECH-A.MIECH)/(IICH◆P71GE9(-1)) = MU28◆(C810+C811◆QFYP
        +C823◆(FDSR(-1)-QDSRT(-1)))+100◆KAPPA28/(IICH◆P71GE9(-1))◆EXP
        (PSI28+RHO28◆QT50+TAU28)

321:    FNETHC-A.FNETHC = C825+C826◆ENETDW+C827◆(ETLDC-MTLDC)

322:    FCREP-A.FCREP = C828+C829◆FDEBT(-1)

323:    FDEBT = FDEBT(-1)+FCDP9-FCREP

324:    FINT-A.FINT = C830+C831◆FDEBT(-1)

325:    FDHC = FNETHC+FSEP9+FCDP9+FGSALE-FINT-FCREP

326:    FSTK = FSTK(-1)+FDHC

327:    FGOLDT = FGOLDT(-1)+XGOLDT9-FGSALE/PGOLD9

328:    FGOLDD = FGOLDT◆PGOLD9

329:    FDSR-A.FDSR = (FCREP+FINT)/ETDW

```
330:        P.CRD70 = EXP(LOG(NPOP9)+LOG(GAMMAD)+BETAD*QT50+LOG(0.011))

331:        P.CRF70 = EXP(LOG(NPOP9)+LOG(GAMMAF)+BETAF*QT50+LOG(0.249))

332:        P.CRND70 = EXP(LOG(NPOP9)+LOG(GAMMAND)+BETAND*QT50+LOG(0.07))

333:        P.CRS70 = EXP(LOG(NPOP9)+LOG(GAMMAS)+BETAS*QT50+LOG(0.093))

334:        GNPA = C947/C948*(XAGSUM-AFEED70-AVCP70)

335:        GNPNA = C949*XDIN+C950*XDCN+C951*XDTC+C952*XDDT+C953*XDSV+
               C954/C955*NMD9

336:        GNP = (GNPA+GNPNA)/C956

337:        GNMP = GNPA+C957*XDIN+C958*XDCN+C959*C960*XDTC+C961*C962*XDDT

338:        ZWUM = (ZSW-NASDV*WAS/1000.)/(PCD70/100.)+ZMPA

339:        EPRIND == 1.38*XDME+XDCH*0.642+XDMB*0.656+(XDPP*0.654+XDCP*
               0.346)*0.46+XDEP*0.505+(XDFP*0.105+XDPA*0.17+XDCM*0.101+XDSG*
               0.334+XDPF*0.384)*1.241

340:        UELIN/EPRIND = 1.109-0.1086*XELP/KELPC+0.1673*KITOT/XDIN

341:        UELAG/XAGT70 = 0.9389-0.299*XELP/KELPC+0.3526*KAIR/XAGTN-
               0.5329*(XAGT70/XAGTN-1.)

342:        UELTR/HFTOT = 0.0243-0.00329*XELP/KELPC+0.01956*PHRLE9

343:        (UELHHM-A.UELHHM)/NPOPU = 0.6685-0.2065*XELP/KELPC+0.7546*(
               SUM(I = -6 TO 0 : CRD70(I))/NPOPU)+0.5045*ZWUM/NPOPU

344:        (UELCN-A.UELCN)/XDCN = 0.1394+0.08234*KCP/XDCN

345:        UELOSS/XELP/(UELOSS(-1)/XELP(-1))-1. = 0.0468+1.79952*(
               XELPCTL9/XELPCTL9(-1)-1.)-0.01393*QLT50

346:        XELP = UELIN+UELAG+UELTR+UELHHM+UELCN+UELOSS+EFTEP

347:        XELAP = (3.77+0.0164*QT50)*KELAPC9

348:        XELHP = 28.605+2.712*KELHPC9

349:        (KELPC-A.KELPC)/KIEP = 13.878-2.91823*QLT50

350:        KELTPC = KELPC-KELAPC9-KELHPC9

351:        XELTP = XELP-XELHP-XELAP
```

352: UFXELTP/XELTP = 0.4568+0.15◆(UCOXELTP/XELTP)-0.12208◆(OLT50-3.2581)

353: UCOXELTP/UFXELTP = CMCOE9◆(KELTPC-0.98◆KELTPC(-1))/KELTPC+UCOXELTP(-1)/UFXELTP(-1)◆0.98◆KELTPC(-1)/KELTPC

354: UFPXELTP/UFXELTP = ·CMPPE9◆(KELTPC-0.98◆KELTPC(-1))/KELTPC+UFPXELTP(-1)/UFXELTP(-1)◆0.98◆KELTPC(-1)/KELTPC

355: UGAXELTP/UFXELTP = CMGAE9◆(KELTPC-0.98◆KELTPC(-1))/KELTPC+UGAXELTP(-1)/UFXELTP(-1)◆0.98◆KELTPC(-1)/KELTPC

356: OUTPUTNT == 1.57119◆XOIN+0.25379◆XOCN+5.32/3.535◆NMD9+0.70484/0.74116◆(XAGTN-AVCP70)

357: HFTOT/OUTPUTNT = 6.164+9.395◆((XTOIPEU+XTCOPEU)/(XTOIP+XTCOP))+1.866◆OLT50

358: LOG(0.25/(KAUTO/NPOP9/1000.)-1.) = 7.41227-0.18476◆OT50

359: UFLPPT/HFTOT = 0.05309-0.01222◆OLT50

360: LOG(1.-0.1/UCOMF) = 0.000935-0.000269◆OT50

361: UFLPPNT/OUTPUTNT = 0.477295-0.03832◆OLT50

362: ULPPMF = UFLPPT+UFLPPNT+KAUTO/1000.

363: TPPIND == (-30.462+0.679◆XOME)◆3.+(-4.168+0.1436◆XOCP+(-2.76+0.1568◆XOPP))◆7.2+(0.663+0.8379◆XOMB)◆2.4+(-2.3257+0.2421◆XOCH)◆7.3+(-15.067+0.3158◆XOFP+(-2.562+0.0545◆XOPA))◆4.4+(-2.334+0.1881◆XOCM)◆6.9+(-77.142+1.4232◆XO3G)◆0.8+(-78.522+1.6965◆XOFF)◆1.6

364: UTPIND/TPPIND = 1.892-0.285◆OLT50

365: UTPHHM/NPOPU = -1.3289+2.3756◆OLT50

366: UTPLOSS/UTPTOT = -0.009195+0.005436◆OLT50

367: UTPF == 1815◆(0.82◆(-33.0653+0.63462◆XOME+22.9214◆OLT50)+0.18◆XOCM)/104.697

368: UTPTOT = (UTPIND+UTPHHM+UTPF)/(1-(-0.009195+0.005436◆OLT50))

369: KELTET3/KELPC = 0.151789+0.038982◆OLT50

370: XTPTET3 = 25.24+14.96◆KELTETS

371: $(UFBF-0.15*UCOBF)/(UTPTOT-XTPTETS-XTPSEC9) = 0.1297+0.000107*$
QT50

372: $DKTP == 0.52*(5.2*KIFM+4.9*KIMB+8.9*KICH+8.2*KIFP+8.2*KICM+$
$5.5*KISG+8.1*KIPF)/867.41+0.48*(37.8*KIFM+12.1*KICM)/977.11$

373: $UCOBF/UFBF = CMCOT9*(DKTP-0.95*DKTP(-1))/DKTP+UCOBF(-1)/UFBF($
$-1)*0.95*DKTP(-1)/DKTP$

374: $UPPBF/UFBF = CMPPT9*(DKTP-0.95*DKTP(-1))/DKTP+UPPBF(-1)/UFBF($
$-1)*0.95*DKTP(-1)/DKTP$

375: $UGABF/UFBF = CMGAT9*(DKTP-0.95*DKTP(-1))/DKTP+UGABF(-1)/UFBF($
$-1)*0.95*DKTP(-1)/DKTP$

376: $UCOKE/XOME = 2.02895-0.44277*QLT50$

377: $UFSK = -105.55+33.35*LOG(XOCH)$

378: $UCO = UCOXELTP+UCOBF+UCOMF+UCOKE$

379: $UHPP = UPPXELTP+UPPBF+UHPPMF9+UHPPFSK9$

380: $ULPP = ULPPMF+ULPPFSK9$

381: $UGA = UGAXELTP+UGABF+UGAFSK9$

382: $UFDIRECT = UCOKE+UFSK$

383: $UFMF = UCOMF+UHPPMF9+ULPPMF$

384: $UF = UFXELTP+UFDIRECT+UFBF+UFMF$

385: $UFT = 0.6993*UCONT+1.43*UPPNT+1.195*UGANT$

386: $XTCOPEU = XTCOP-(328.457+1.203*QT50)$

387: $XTOIPEU = XTOIP-(-3626.5+2440.4*QLT50-379.163*QLT50**2)$

388: $XTGANEU = XTGAN-(44334.+4292.5*QT50)$

389: $XOPPEU == (0.6093*(XTOIPEU/353.039)+0.3907*(XTGANEU/197945.))$
$*100.$

390: $KREPOI-A.KREPOI = (-2.8+1.2*QLT50)*(0.18127*KNEWOI(-1)+$
$0.14841*KNEWOI(-2)+0.12151*KNEWOI(-3)+0.09948*KNEWOI(-4)+$
$0.08145*KNEWOI(-5)+0.06669*KNEWOI(-6)+0.05459*KNEWOI(-7)+$
$0.0447*KNEWOI(-8)+0.0366*KNEWOI(-9)+0.02996*KNEWOI(-10))$

391: $KNEWOI-A.KNEWOI = KREPOI+XTOIP-XTOIP(-1)$

392: XTCOP-A.XTCOF = 39.4218+7.162*XDCP-42.7276*QLT50

393: EFEECO-A.EFEECO = 100.246*YCMEA9-0.478*(FDEBT-FSTK)

394: EFEEDI-A.EFEEDI = -38674.6+525.253*YCMEA9-1.31083*(FDEBT-FSTK
)

395: EFEEGA-A.EFEEGA = -4599.07+45.3527*YCMEA9+0.101152*EFRWGA

396: EFRWCO-A.EFRWCO = 18324.9-0.380116*EFEECO+0.192081*(FDEBT-
      FSTK)

397: EFRWDI-A.EFRWDI = 38272.7+191.061*ZWAIP79+2.30906*(FDEBT-FSTK
)-173.204*EFRWDI

398: EFRWGA-A.EFRWGA = -23072.4+131.985*ZWAIP79+1001.98*EFRWGA

399: EFTEP-A.EFTEP = -12.1605+0.1143*YCMEA9

400: EFEECO-A.EFEECO = 0.67965*EFEECO(-1)+0.386731*EFRWCO

TROLL COMMAND: .PRTMOD EQ 401 TO 500:

MODEL: CURRENT

401: EFEEDI-A.EFEEDI = 0.796025*EFEEDI(-1)+0.158393*EFRWDI

402: EFEEGA-A.EFEEGA = (-0.053997)*EFEEGA(-1)+1.19672*EFRWGA

403: (XDCP-A.XDCP)/XDCP(-1)-1 = C533*(NMICP/NMICP(-1)-1)+C534*(
      KICP/KICP(-1)-1)+C535*061+C1029*QLIM

404: P.XIOME = EXP(C1ME+C3ME*(PGVOME*LOG(MINPUTME)+WGVOME*LOG(
      NHRIND*NMIME)+(1-PGVOME-WGVOME)*LOG(1.5*KIFM)))

405: P.XIOMB = EXP(C1MB+C3MB*(PGVOMB*LOG(MINPUTMB)+WGVOMB*LOG(
      NHRIND*NMIMB)+(1-PGVOMB-WGVOMB)*LOG(KIMB)))

406: P.XIOCH = EXP(C1CH+C3CH*(PGVOCH*LOG(MINPUTCH)+WGVOCH*LOG(
      NHRIND*NMICH)+(1-PGVOCH-WGVOCH)*LOG(KICH)))

407: P.XIOFP = EXP(C1FP+C3FP*(PGVOFP*LOG(MINPUTFP)+WGVOFP*LOG(
      NHRIND*NMIFP)+(1-PGVOFP-WGVOFP)*LOG(KIFP)))

408: P.XIOPA = EXP(C1PA+C3PA*(PGVOPA*LOG(MINPUTPA)+WGVOPA*LOG(
      NHRIND*NMIPA)+(1-PGVOPA-WGVOPA)*LOG(KIFP)))

409: P.XIOCM = EXP(C1CM+C3CM*(PGVOCM*LOG(MINPUTCM)+WGVOCM*LOG(
      NHRIND*NMICM)+(1-PGVOCM-WGVOCM)*LOG(KICM)))

410: P.XIOPF = EXP(C1PF+C3PF*(PGVOPF*LOG(MINPUTPF)+WGVOPF*LOG(
      NHRIND*NMIPF)+(1-PGVOPF-WGVOPF)*LOG(KIFF)))

END
DATE
FILMED
8-82
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MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A
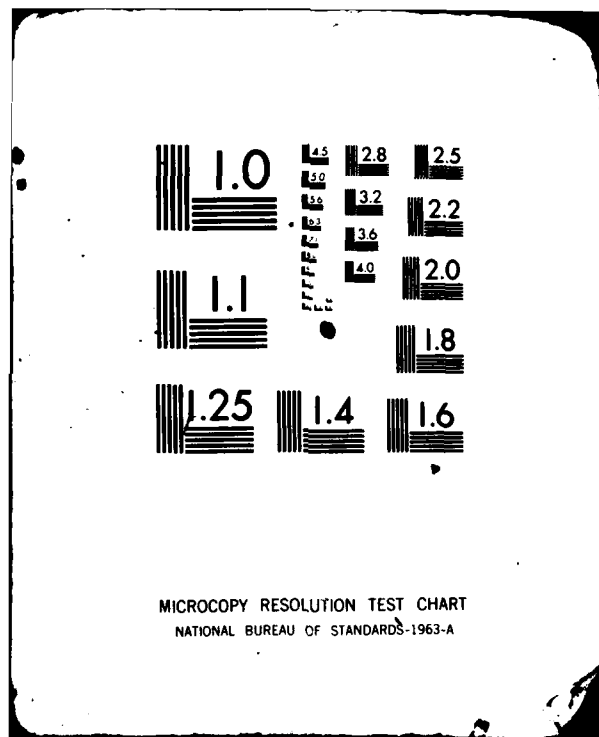
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411:    P.XIOCN = EXP(C1CN+C3CN*(PGVOCN*LOG(MINPUTCN)+WGVOCN*LOG(
        NHRIND*NMC)+(1-PGVOCN-WGVOCN)*LOG(KCR)))

412:    P.XIOSG = EXP(C1SG+C3SG*(PGVOSG*LOG(MINPUTSG)+WGVOSG*LOG(
        NHRIND*NMISG)+(1-PGVOSG-WGVOSG)*LOG(KISG)))

413:    P.XIOAG = EXP(C1AG+C3AG*(PGVOAG*LOG(MINPUTAG)+WGVOAG*LOG(
        NHRIND*NAT)+(1-PGVOAG-WGVOAG)*LOG(KAIR))+C4AG*LOG(ASGR9)+C5AG
        *JPS9+C6AG*JTW9+C7AG*Q75)

414:    P.XIONC = EXP(C1NC+C3NC*(PGVONC/(WGVONC+PGVONC)*LOG(MINPUTNC)
        +WGVONC/(WGVONC+PGVONC)*LOG(NHRIND*NMINC)))

415:    P.XIODB = EXP(C1DB+C3DB*(PGVODB/(WGVODB+PGVODB)*LOG(MINPUTDB)
        +WGVODB/(WGVODB+PGVODB)*LOG(NHRIND*NMO)))

416:    ETAINA = IF DKIMB(-1) EQ 0 THEN ETAINA(-1) ELSE (1-DBAR(-1)*
        DKIMB(-1))*ETAINA(-1)

417:    ETAIAM = IF DKIMB(-1) EQ 0 THEN ETAIAM(-1) ELSE (1-DBAR(-1)*
        DKIMB(-1))*ETAIAM(-1)

418:    ETAIAC = IF DKIMB(-1) EQ 0 THEN ETAIAC(-1) ELSE (1-DBAR(-1)*
        DKIMB(-1))*ETAIAC(-1)

419:    P.INA = EXP(DELTAINA+ZETAINA*QT50+LOG(ETAINA))

420:    P.IAM = EXP(DELTAIAM+ZETAIAM*QT50+LOG(ETAIAM))

421:    P.IAC = EXP(DELTAIAC+ZETAIAC*QT50+LOG(ETAIAC))

422:    P.BRD = EXP(NUBRD+IOTABRD*QT50+LOG(SIGMABRD))

423:    P.BAD = EXP(NUBAD+IOTABAD*QT50+LOG(SIGMABAD))

424:    P.CR70 = P.CRF70+P.CRND70+P.CRD70+P.CRS70

425:    UCONT = (UCOXELTP+UCOBF+UCOMF)*1.4+UCOKE*1.25*1.037*1.2*1.04+
        XTCOP*0.12

426:    UPPNT = XTOIP*0.109+(ULPP+UHPP)*0.71

427:    UGANT = XTGAN*0.094/1000.+UGA*0.818

428:    (RXTOIP*XTOIP-A.XTOIP-XTOIP(-1)+KREPOI)*1000/(IPPDRLD9+
        IPPDRLD9(-1)+IPPDRLD9(-2)) = 2.74434-0.03553*QT50+5.03193*
        XTOIPEU(-1)/XTOIP(-1)

429:    (RXTGAN*XTGAN-A.XTGAN)/HPTGA = 3109.18-720.071*XTGANEU(-1)/
        XTGAN(-1)

430:    XOME = EXP(CG1+CG2*(QSH68-QSH73)+(CG4+CG5*(QSH68-QSH73)+CG6*
        QSH73)*LOG(XIOME)+CG7*Q67)
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431:     XOMB = EXP(CG8+CG9*(QSH68-QSH73)+CG10*QSH73+(CG11+CG12*(QSH68
         -QSH73)+CG13*QSH73)*LOG(XIOMB))

432:     XOCH = EXP(CG15+CG17*QSH73+(CG18+CG20*QSH73)*LOG(XIOCH)+CG21*
         Q67)

433:     XOFP = EXP(CG22+CG623*(QSH68-QSH73)+CG24*QSH73+CG625*LOG(XIOFP)
         +CG28*Q67)

434:     XOPA = EXP(CG29+CG30*(QSH68-QSH73)+(CG632+CG633*(QSH68-QSH73)+
         CG34*QSH73)*LOG(XIOPA))

435:     XOCM = EXP(CG36+CG637*(QSH68-QSH73)+CG638*QSH73+CG639*LOG(XIOCM)
         )

436:     XOSG = EXP(CG43+CG44*(QSH68-QSH73)+(CG46+CG647*(QSH68-QSH73)+
         CG48*QSH73)*LOG(XIOSG))

437:     XOPF = EXP(CG50+CG52*QSH73+CG53*LOG(XIOPF))

438:     XOCN = EXP(CG57+CG58*QSH68+(CG60+CG61*QSH68)*LOG(XIOCN))

439:     XOTC = EXP(CG64+CG65*(QSH68-QSH73)+CG66*QSH73+(CG67+CG68*(
         QSH68-QSH73)+CG69*QSH73)*LOG(XIOTC)+CG70*Q67)

440:     XODT = EXP(CG71+CG73*QSH73+CG74*LOG(XIODT))

441:     P.XIOCP = EXP(CG78+CG679*QSH68+(CG81+CG82*QSH68)*LOG(XOCP)+
         CG84*Q67)

442:     XIDEP = EXP(CG85+0*QSH68+(CG88+0*QSH68)*LOG(XOEP)+CG91*Q67)

443:     P.XIODI = EXP(CG92+CG693*(QSH68-QSH73)+CG94*QSH73+(CG95+CG96*(
         QSH68-QSH73)+CG97*QSH73)*LOG(XTDIP)+CG98*Q67)

444:     P.XIOGA = EXP(CG113+CG114*(QSH68-QSH73)+CG119*QSH73+(CG115+
         CG116*(QSH68-QSH73)+CG117*QSH73)*LOG(XTGAN/1000.)+CG118*Q67)

445:     XAGSUM = EXP(CM1+(CM4+CM6*QSH73)*LOG(XIOAG))

446:     TT70 == TT/PCD70*100

447:     TT70IO == 1.007*TT70

448:     TT70IOF == 0.711*TT70IO

449:     TT70IOC == 0.9008*TT70IOF

450:     TT70IOM == 0.0159*TT70IOF

451:     TT70IOG == 0.0833*TT70IOF

452:     P.ERM == (ERMCM+EFUELDW+EOMDW+EOSC+ETCH+ECUBA+EUSW9)/1000
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453:        P.EMM == (EMACM+EMADW+EARMLDC9)/1000

454:        P.EFM == (EGRCM+ECDCM+EGRDW+EFODW+0.7*EODW)/1000

455:        P.ECM == (ETLDC+0.3*EODW)/1000

456:        P.ERPR == P.ERM/(PPEX9*PTX9/97)*7000/4736

457:        P.EMPR == P.EMM/(PREX9*PTX9/97)*1856/1361.1

458:        P.EFPR == P.EFM/(PREX9*PTX9/97)*742/815.6

459:        P.ECPR == P.ECM/(PREX9*PTX9/97)*758/933.4

460:        P.MRM == (MRMCM+MRMDW+MTLDC+0.33*MDSC)/1000

461:        P.MMM == (MMACM+MMADW+0.4*MDSC)/1000

462:        P.MFM == (MFDCM+MCUBA+0.3*MTCH+MUSDW9+MUSCM9)/1000

463:        P.MCM == (MCDCM+MCDDW+0.27*MDSC+0.7*MTCH)/1000

464:        P.MRPU == P.MRM/(PREX9*PTM9/94)*2672/2043

465:        P.MMPU == P.MMM/(PREX9*PTM9/94)*1683.7/2371.5

466:        P.MFPU == P.MFM/(PPEX9*PTM9/94)*1790.8/1124.9

467:        P.MCPU == P.MCM/(PPEX9*PTM9/94)*4998.7/1209.3

468:        P.MGPR == P.MGRDW/PWUS*0.001*103*798/679

469:        P.MPU == P.MRPU+P.MMPU+1.33*P.MFPU+P.MCPU

470:        P.MRPR == (P.MRPU-P.MRPU/P.MPU*TT70IDM/0.9456)*(2591/2558)

471:        P.MMPR == (P.MMPU-P.MMPU/P.MPU*TT70IDM/0.9456)*(1793/1612)

472:        P.MFPR == (P.MFPU-P.MFPU/P.MPU*TT70IDM/0.9456)*(1741/1714.5)

473:        P.MCPR == (P.MCPU-P.MCPU/P.MPU*TT70IDM/0.9456)*(4__    786)

474:        MIO == MRPR+MMPR+MFPR+MCPR+MGPR

475:        P.CRS70G == P.CRS70-NMG*1282.83*1.000000E-06

476:        P.CFPU == 1.01433*P.CRF70

477:        P.CNPU == 0.91868*P.CRND70

478:        P.CDPU == 0.95651*P.CRD70

479:        P.CSPU == 0.14305*P.CRS70G
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480:        P.CPU == P.CFPU+P.CNPU+P.CDPU+P.CSPU

481:        P.TT70CF == TT70IDC*P.CFPU/P.CPU

482:        P.TT70CN == TT70IDC*P.CNPU/P.CPU

483:        P.TT70CD == TT70IDC*P.CDPU/P.CPU

484:        P.TT70CS == TT70IDC*P.CSPU/P.CPU

485:        P.CFPR == P.CFPU-P.TT70CF

486:        P.CNPR == P.CNPU-P.TT70CN

487:        P.CDPR == P.CDPU-P.TT70CD

488:        P.CSPR == P.CSPU-P.TT70CS

489:        CID == CFPR+CNPR+CDPR+CSPR

490:        P.IM == (P.IAM+(0.0679+0.0806*QLT50)*P.INA)*18500/18278

491:        P.IC == (CA1+CA2*(QSH68-QSH73)+CA6*QSH73+(CA3+CA4*(QSH68-
            QSH73)+CA7*QSH73)*QLT50+CA5*Q67)*P.ITOTAL

492:        P.IRID == 186.11*P.ICR/1000

493:        P.GPHS == P.CRS70*0.105*1316/4340*1518/1373-0.104*TT70IDG

494:        P.GNTC == P.CRS70*0.161*1438/7380*1648/1353-0.113*TT70IDG

495:        P.GHEC == P.CRS70*0.577*6176/22150*7405/6938-0.507*TT70IDG

496:        P.GSBA == (17*P.BAD/1000+99.27*P.BRD/1000)*3430/9619*4027/
            3287-0.276*TT70IDG

497:        P.GID == P.GPHS+P.GNTC+P.GHEC+P.GSBA

498:        INV01 = CF200+CF201*XIDME+CF202*QQT50+CF203*Q67

499:        INV02 = CZ204+CZ205*(1-Q67SH)+CZ213*QSH73+CZ206*Q67SH*(
            P.XIDCP-P.XIDCP(-1))+(CZ207*(1-Q67SH)+CZ208*QSH73)*P.XIDCP+(
            CZ209+CZ210*(1-Q67SH)+CZ212*QSH73)*QQT50

500:        INV03 = CX209+CX210*(QSH68-QSH73)+CX211*QSH73+(CX212+CX213*
            QSH68)*P.XIDDI+(CX214+CX215*QSH68)*QQT50
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501:        INV04 = CF213+CF214+XIOGA+CF215+QQT50

502:        INV05 = CF216+CF217+XIOEP+CF218+(XIOEP-XIOEP(-1))+CF219+QQT50

503:        ETAMD = IF DKIMB(-1) EQ 0 THEN ETAMD(-1) ELSE (1-DBAR(-1)+
            DKIMB(-1))+ETAMD(-1)

504:        MDMIDPD = EXP(DELTAMD+ZETAMD+QT50+LOG(ETAMD))

505:        BRESID06 = CY1+CY2+(1-QSH68)+CY3+(1-QSH68)+(XIOMB-XIOMB(-1))+
            (CY4+CY5+(1-QSH68))+(XIOMB-MDMIDPD)+CY6+RESID06(-1)+CY7+
            RESID06(-2)+CY8+Q74

506:        RESID06 = IF BRESID06/XIOMB GT 0.08 THEN 0.08+XIOMB ELSE (IF
            BRESID06/XIOMB LT -0.08 THEN (-0.08)+XIOMB ELSE BRESID06)

507:        INV06 == RESID06+MDMIDPD

508:        INV07 = CF224+CF225+XIOCH

509:        INV08 = CQ227+CQ229+QQT50+CQ230+(XIOFP-XIOFP(-1))+CQ231+Q67

510:        INV09 = CF230+CF231+XIOPA+CF232+(XIOPA-XIOPA(-1))+CF233+QQT50

511:        INV10 = CT234+CT235+XIOCM+CT237+QQT50+CT238+Q73+CT239+Q75

512:        B.INV11 == CF238+CF239+XIOSG+CF240+(CRND70-CRND70(-1))+CF241+
            QQT50

513:        INV11 = IF B.INV11 LT (-0.1)+XIOSG THEN (-0.1)+XIOSG ELSE (
            IF B.INV11 GT 0.1+XIOSG THEN 0.1+XIOSG ELSE B.INV11)

514:        B.INV12 == CF243+CF244+XIOPF+CF245+(XIOPF-XIOPF(-1))+CF246+
            Q69

515:        INV12 = IF B.INV12 GT 0.039+XIOPF THEN 0.039+XIOPF ELSE (IF
            B.INV12 LT (-0.047)+XIOPF THEN (-0.047)+XIOPF ELSE B.INV12)

516:        INV13 = CF300+CF301+XIONC+CF303+QQT50+0+Q67

517:        UNFINC = CR1+CR9+(QSH68-QSH73)+CR3+(XIOCM-XIOCM(-1))+CR5+JPW9
            +CR7+QSH73+CR8+QFYP

518:        OTHERCON = CCR1+CCR2+XIOCN+CCR5+QFYP

519:        RESID14 = CD1+CD2+(QSH68-QSH73)+CD3+QSH73+(CD4+CD5+(QSH68-
            QSH73))+(XIOCN-XIOCN(-1))+CD7+QSH68+QQT50+CD8+Q73

520:        INV14 == UNFINC+OTHERCON+RESID14

521:        RESID15 = CC1+CC2+(XIOAG-XIOAG(-1))+CC3+JPS9+CC5+JPW9+CC6+Q75
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522:        INV15 == RESID15+ADLVR

523:        INV16 = CF259+CF260*XIOTC+CF261*(XIOTC-XIOTC(-1))+CF262*QT50

524:        B.INV17 == CF263+CF264*XIODT+CF265*(XIODT-XIODT(-1))+CF266*
            QT50

525:        INV17 = IF B.INV17 GT 0.053*XIODT THEN 0.053*XIODT ELSE (IF
            B.INV17 LT (-0.019)*XIODT THEN (-0.019)*XIODT ELSE B.INV17)

526:        INV18 = CF267+CF268*XIODB+CF269*(XIODB-XIODB(-1))+CF270*00T50

527:        FRES == INV01+INV02+INV03+INV04+INV05+INV06+INV07+INV08+INV09
            +INV10+INV11+INV12+INV13+INV14+INV15+INV16+INV17+INV18

528:        NMPRES-ADLVR = CF400+CF401*(FRES-ADLVR)+CF402*QSH69+CF403*Q73

529:        F01 == 0.00139*CDPR+0.0206*GPHS+0.0197*GNTC+0.0015*GHEC+
            0.1809*GSBA-0.3705*MRPR+0.457857*ERPR

530:        F02 == 0.08356*CSPR+0.1665*GPHS+0.2405*GNTC+0.0345*GHEC+
            0.0458*GSBA-0.110821*MRPR+0.056571*ERPR

531:        F03 == 0.03857*CSPR+0.0634*GPHS+0.0914*GNTC+0.013*GHEC+0.0173
            *GSBA-0.033209*MRPR+0.269286*ERPR

532:        F04 == 0.02939*CSPR+0.0063*GPHS+0.0088*GNTC+0.0013*GHEC+
            0.0018*GSBA+0.003429*ERPR

533:        F05 == 0.40955*CSPR+0.1483*GPHS+0.098*GNTC+0.0438*GHEC+0.0446
            *GSBA+0.003286*ERPR

534:        F06 == 0.49278*CDPR+0.073*GPHS+0.1506*GNTC+0.0278*GHEC+0.2626
            *GSBA-1*MMPR+1*EMPR+0.95*IM+0.483*IRIO

535:        F07 == 0.29109*CSPR+0.0611*GPHS+0.0833*GNTC+0.0758*GHEC+
            0.1373*GSBA-0.305224*MRPR+0.067429*ERPR

536:        F08 == 0.30708*CDPR+0.0888*GPHS+0.027*GNTC+0.0197*GHEC+0.0553
            *GSBA-0.101119*MRPR+0.11*ERPR

537:        F09 == 0.0151*GPHS+0.0044*GNTC+0.0034*GHEC+0.0093*GSBA-
            0.045522*MRPR+0.017571*ERPR

538:        F10 == 0.02889*CDPR+0.0412*GPHS+0.0132*GNTC+0.0094*GHEC+
            0.0245*GSBA-0.010821*MRPR+0.005143*ERPR

539:        F11 == 0.79273*CNPR+0.0603*GPHS+0.027*GNTC+0.0856*GHEC+0.0395
            *GSBA-0.980901*MCPR+0.960422*ECPR

540:        F12 == 0.5245*CFPR+0.027*GPHS+0.0124*GNTC+0.3619*GHEC+0.0114*
            GSBA-0.743251*MFPR+0.512129*EFPR
```

541:     F13 == 0.12507*CNPR+0.0642*GPHS+0.0614*GNTC+0.0522*GHEC+
0.0105*GSBA-0.018496*MCPR-0.017537*MRPR+0.031662*ECPR+
0.004857*ERPR

542:     F14 == 1*IC+0.494*IRIO

543:     F15 == 0.32088*CFPR+0.0891*GHEC-0.256749*MFPR-1*MGPR+0.487871
*EFPR

544:     F16 == 0.02006*CFPR+0.01157*CNPR+0.06612*CSPR+0.07458*CDPR+
0.0904*GPHS+0.0958*GNTC+0.0368*GHEC+0.0622*GSBA+0.039*IM+
0.019*IRIO

545:     F17 == 0.10495*CFPR+0.0706*CNPR+0.08173*CSPR+0.09528*CDPR+
0.0738*GPHS+0.0665*GNTC+0.1113*GHEC+0.0972*GSBA+0.011*IM+
0.005*IRIO

546:     F18 == 0.02961*CFPR+0.033*GHEC-0.000603*MCPR-0.005224*MRPR+
0.007916*ECPR+0.004571*ERPR

547:     G01 == XIOME-A0101*XIOME-A0102*XIOCP-A0103*XIODI-A0104*XIOGA-
A0105*XIOEP-A0106*XIOMB-A0107*XIOCH-A0108*XIOFP-A0109*XIOPA-
A0110*XIOCM-A0111*XIOSG-A0112*XIOPF-A0113*XIONC-A0114*XIOCN-
A0115*XIOAG-A0116*XIOTC-A0117*XIODT-A0118*XIOOB

548:     G02 == XIOCP-A0201*XIOME-A0202*XIOCP-A0203*XIODI-A0204*XIOGA-
A0205*XIOEP-A0206*XIOMB-A0207*XIOCH-A0208*XIOFP-A0209*XIOPA-
A0210*XIOCM-A0211*XIOSG-A0212*XIOPF-A0213*XIONC-A0214*XIOCN-
A0215*XIOAG-A0216*XIOTC-A0217*XIODT-A0218*XIOOB

549:     G03 == XIODI-A0301*XIOME-A0302*XIOCP-A0303*XIODI-A0304*XIOGA-
A0305*XIOEP-A0306*XIOMB-A0307*XIOCH-A0308*XIOFP-A0309*XIOPA-
A0310*XIOCM-A0311*XIOSG-A0312*XIOPF-A0313*XIONC-A0314*XIOCN-
A0315*XIOAG-A0316*XIOTC-A0317*XIODT-A0318*XIOOB

550:     G04 == XIOGA-A0401*XIOME-A0402*XIOCP-A0403*XIODI-A0404*XIOGA-
A0405*XIOEP-A0406*XIOMB-A0407*XIOCH-A0408*XIOFP-A0409*XIOPA-
A0410*XIOCM-A0411*XIOSG-A0412*XIOPF-A0413*XIONC-A0414*XIOCN-
A0415*XIOAG-A0416*XIOTC-A0417*XIODT-A0418*XIOOB

551:     G05 == XIOEP-A0501*XIOME-A0502*XIOCP-A0503*XIODI-A0504*XIOGA-
A0505*XIOEP-A0506*XIOMB-A0507*XIOCH-A0508*XIOFP-A0509*XIOPA-
A0510*XIOCM-A0511*XIOSG-A0512*XIOPF-A0513*XIONC-A0514*XIOCN-
A0515*XIOAG-A0516*XIOTC-A0517*XIODT-A0518*XIOOB

552:     G06 == XIOMB-A0601*XIOME-A0602*XIOCP-A0603*XIODI-A0604*XIOGA-
A0605*XIOEP-A0606*XIOMB-A0607*XIOCH-A0608*XIOFP-A0609*XIOPA-
A0610*XIOCM-A0611*XIOSG-A0612*XIOPF-A0613*XIONC-A0614*XIOCN-
A0615*XIOAG-A0616*XIOTC-A0617*XIODT-A0618*XIOOB

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553:      G07 == XIDCH-A0701◆XIDME-A0702◆XIDCP-A0703◆XIDDI-A0704◆XIDGA-
          A0705◆XIDEP-A0706◆XIDMB-A0707◆XIDCH-A0708◆XIDFP-A0709◆XIDPA-
          A0710◆XIDCM-A0711◆XIDSG-A0712◆XIDPF-A0713◆XIDNC-A0714◆XIDCN-
          A0715◆XIDAG-A0716◆XIDTC-A0717◆XIDDT-A0718◆XIDDB

554:      G08 == XIDFP-A0801◆XIDME-A0802◆XIDCP-A0803◆XIDDI-A0804◆XIDGA-
          A0805◆XIDEP-A0806◆XIDMB-A0807◆XIDCH-A0808◆XIDFP-A0809◆XIDPA-
          A0810◆XIDCM-A0811◆XIDSG-A0812◆XIDPF-A0813◆XIDNC-A0814◆XIDCN-
          A0815◆XIDAG-A0816◆XIDTC-A0817◆XIDDT-A0818◆XIDDB

555:      G09 == XIDPA-A0901◆XIDME-A0902◆XIDCP-A0903◆XIDDI-A0904◆XIDGA-
          A0905◆XIDEP-A0906◆XIDMB-A0907◆XIDCH-A0908◆XIDFP-A0909◆XIDPA-
          A0910◆XIDCM-A0911◆XIDSG-A0912◆XIDPF-A0913◆XIDNC-A0914◆XIDCN-
          A0915◆XIDAG-A0916◆XIDTC-A0917◆XIDDT-A0918◆XIDDB

556:      G10 == XIDCM-A1001◆XIDME-A1002◆XIDCP-A1003◆XIDDI-A1004◆XIDGA-
          A1005◆XIDEP-A1006◆XIDMB-A1007◆XIDCH-A1008◆XIDFP-A1009◆XIDPA-
          A1010◆XIDCM-A1011◆XIDSG-A1012◆XIDPF-A1013◆XIDNC-A1014◆XIDCN-
          A1015◆XIDAG-A1016◆XIDTC-A1017◆XIDDT-A1018◆XIDDB

557:      G11 == XIDSG-A1101◆XIDME-A1102◆XIDCP-A1103◆XIDDI-A1104◆XIDGA-
          A1105◆XIDEP-A1106◆XIDMB-A1107◆XIDCH-A1108◆XIDFP-A1109◆XIDPA-
          A1110◆XIDCM-A1111◆XIDSG-A1112◆XIDPF-A1113◆XIDNC-A1114◆XIDCN-
          A1115◆XIDAG-A1116◆XIDTC-A1117◆XIDDT-A1118◆XIDDB

558:      G12 == XIDPF-A1201◆XIDME-A1202◆XIDCP-A1203◆XIDDI-A1204◆XIDGA-
          A1205◆XIDEP-A1206◆XIDMB-A1207◆XIDCH-A1208◆XIDFP-A1209◆XIDPA-
          A1210◆XIDCM-A1211◆XIDSG-A1212◆XIDPF-A1213◆XIDNC-A1214◆XIDCN-
          A1215◆XIDAG-A1216◆XIDTC-A1217◆XIDDT-A1218◆XIDDB

559:      G13 == XIDNC-A1301◆XIDME-A1302◆XIDCP-A1303◆XIDDI-A1304◆XIDGA-
          A1305◆XIDEP-A1306◆XIDMB-A1307◆XIDCH-A1308◆XIDFP-A1309◆XIDPA-
          A1310◆XIDCM-A1311◆XIDSG-A1312◆XIDPF-A1313◆XIDNC-A1314◆XIDCN-
          A1315◆XIDAG-A1316◆XIDTC-A1317◆XIDDT-A1318◆XIDDB

560:      G14 == XIDCN-A1401◆XIDME-A1402◆XIDCP-A1403◆XIDDI-A1404◆XIDGA-
          A1405◆XIDEP-A1406◆XIDMB-A1407◆XIDCH-A1408◆XIDFP-A1409◆XIDPA-
          A1410◆XIDCM-A1411◆XIDSG-A1412◆XIDPF-A1413◆XIDNC-A1414◆XIDCN-
          A1415◆XIDAG-A1416◆XIDTC-A1417◆XIDDT-A1418◆XIDDB

561:      G15 == XIDAG-A1501◆XIDME-A1502◆XIDCP-A1503◆XIDDI-A1504◆XIDGA-
          A1505◆XIDEP-A1506◆XIDMB-A1507◆XIDCH-A1508◆XIDFP-A1509◆XIDPA-
          A1510◆XIDCM-A1511◆XIDSG-A1512◆XIDPF-A1513◆XIDNC-A1514◆XIDCN-
          A1515◆XIDAG-A1516◆XIDTC-A1517◆XIDDT-A1518◆XIDDB

562:      G16 == XIDTC-A1601◆XIDME-A1602◆XIDCP-A1603◆XIDDI-A1604◆XIDGA-
          A1605◆XIDEP-A1606◆XIDMB-A1607◆XIDCH-A1608◆XIDFP-A1609◆XIDPA-
          A1610◆XIDCM-A1611◆XIDSG-A1612◆XIDPF-A1613◆XIDNC-A1614◆XIDCN-
          A1615◆XIDAG-A1616◆XIDTC-A1617◆XIDDT-A1618◆XIDDB
```

563:     G17 == XIODT-A1701*XIOME-A1702*XIOCP-A1703*XIODI-A1704*XIOGA-
        A1705*XIOEP-A1706*XIOMB-A1707*XIOCH-A1708*XIOFP-A1709*XIOPA-
        A1710*XIOCM-A1711*XIOSG-A1712*XIOPF-A1713*XIONC-A1714*XIOCN-
        A1715*XIOAG-A1716*XIOTC-A1717*XIODT-A1718*XIOOB

564:     G18 == XIOOB-A1801*XIOME-A1802*XIOCP-A1803*XIODI-A1804*XIOSA-
        A1805*XIOEP-A1806*XIOMB-A1807*XIOCH-A1808*XIOFP-A1809*XIOPA-
        A1810*XIOCM-A1811*XIOSG-A1812*XIOPF-A1813*XIONC-A1814*XIOCN-
        A1815*XIOAG-A1816*XIOTC-A1817*XIODT-A1818*XIOOB

565:     Z22 = G02-F02-INV02

566:     Z23 = G03-F03-INV03

567:     Z24 = G04-F04-INV04

568:     Z01 = G01-F01-INV01

569:     Z06 = G06-F06-RESID06-MDMIDPD

570:     Z07 = G07-F07-INV07

571:     Z08 = G08-F08-INV08

572:     Z09 = G09-F09-INV09

573:     Z10 = G10-F10-INV10

574:     Z11 = G11-F11-INV11

575:     Z12 = G12-F12-INV12

576:     Z14 = G14-F14-UNFINC-OTHERCON-RESID14

577:     Z15 = G15-F15-RESID15-ADLVR

578:     0 = WSUMJ*A21/WW21**2*(CFPR-P.CFPR)-L20-L12*0.5245-L15*
        0.32088-L16*0.02006-L17*0.10495-L18*0.02961

579:     0 = WSUMJ*A22/WW22**2*(CNPR-P.CNPR)-L20-L11*0.79273-L13*
        0.12507-L16*0.01157-L17*0.0706

580:     0 = WSUMJ*A23/WW23**2*(CDPR-P.CDPR)-L20-L01*0.00139-L06*
        0.49273-L08*0.30708-L10*0.02889-L16*0.07458-L17*0.09528

581:     0 = WSUMJ*A24/WW24**2*(CSPR-P.CSPR)-L20-L02*0.08356-L03*
        0.03857-L04*0.02938-L05*0.40955-L07*0.29109-L16*0.06612-L17*
        0.03173

582:   $0 = WSUMJ \bullet A25/WW25 \bullet\bullet 2 \bullet (GPHS-P.GPHS)-L20-L01 \bullet 0.0206-L02 \bullet 0.1665$
$-L03 \bullet 0.0634-L04 \bullet 0.0063-L05 \bullet 0.1483-L06 \bullet 0.073-L07 \bullet 0.0611-L08 \bullet$
$0.0888-L09 \bullet 0.0151-L10 \bullet 0.0412-L11 \bullet 0.0603-L12 \bullet 0.027-L13 \bullet 0.0642-$
$L16 \bullet 0.0904-L17 \bullet 0.0738$

583:   $0 = WSUMJ \bullet A26/WW26 \bullet\bullet 2 \bullet (GNTC-P.GNTC)-L20-L01 \bullet 0.0197-L02 \bullet 0.2405$
$-L03 \bullet 0.0914-L04 \bullet 0.0088-L05 \bullet 0.098-L06 \bullet 0.1506-L07 \bullet 0.0833-L08 \bullet$
$0.027-L09 \bullet 0.0044-L10 \bullet 0.0132-L11 \bullet 0.027-L12 \bullet 0.0124-L13 \bullet 0.0614-$
$L16 \bullet 0.0958-L17 \bullet 0.0665$

584:   $0 = WSUMJ \bullet A27/WW27 \bullet\bullet 2 \bullet (GHEC-P.GHEC)-L20-L01 \bullet 0.0015-L02 \bullet 0.0345$
$-L03 \bullet 0.013-L04 \bullet 0.0013-L05 \bullet 0.0438-L06 \bullet 0.0278-L07 \bullet 0.0758-L08 \bullet$
$0.0197-L09 \bullet 0.0034-L10 \bullet 0.0094-L11 \bullet 0.0856-L12 \bullet 0.3619-L13 \bullet 0.0522$
$-L15 \bullet 0.0891-L16 \bullet 0.0368-L17 \bullet 0.1113-L18 \bullet 0.033$

585:   $0 = WSUMJ \bullet A28/WW28 \bullet\bullet 2 \bullet (GSBA-P.GSBA)-L20-L01 \bullet 0.1809-L02 \bullet 0.0458$
$-L03 \bullet 0.0173-L04 \bullet 0.0018-L05 \bullet 0.0446-L06 \bullet 0.2626-L07 \bullet 0.1373-L08 \bullet$
$0.0553-L09 \bullet 0.0093-L10 \bullet 0.0245-L11 \bullet 0.0395-L12 \bullet 0.0114-L13 \bullet 0.0105$
$-L16 \bullet 0.0622-L17 \bullet 0.0972$

586:   $0 = WSUMJ \bullet A29/WW29 \bullet\bullet 2 \bullet (ERPR-P.ERPR)-L20-L01 \bullet 0.457857-L02 \bullet$
$0.056571-L03 \bullet 0.269286-L04 \bullet 0.003429-L05 \bullet 0.003286-L07 \bullet 0.067429-$
$L08 \bullet 0.11-L09 \bullet 0.017571-L10 \bullet 0.005143-L13 \bullet 0.004857-L18 \bullet 0.004571$

587:   $0 = WSUMJ \bullet A30/WW30 \bullet\bullet 2 \bullet (EFPR-P.EFPR)-L20-L12 \bullet 0.512129-L15 \bullet$
0.487871

588:   $0 = WSUMJ \bullet A31/WW31 \bullet\bullet 2 \bullet (ECPR-P.ECPR)-L20-L11 \bullet 0.960422-L13 \bullet$
$0.031662-L18 \bullet 0.007916$

589:   $0 = WSUMJ \bullet A32/WW32 \bullet\bullet 2 \bullet (EMPR-P.EMPR)-L20-L06$

590:   $0 = WSUMJ \bullet A33/WW33 \bullet\bullet 2 \bullet (MRPR-P.MRPR)+L20+L01 \bullet 0.3705+L02 \bullet$
$0.110821+L03 \bullet 0.033209+L07 \bullet 0.305224+L08 \bullet 0.101119+L09 \bullet 0.045522+$
$L10 \bullet 0.010821+L13 \bullet 0.031662+L18 \bullet 0.005224$

591:   $0 = WSUMJ \bullet A34/WW34 \bullet\bullet 2 \bullet (MMPR-P.MMPR)+L20+L06$

592:   $0 = WSUMJ \bullet A35/WW35 \bullet\bullet 2 \bullet (MFPR-P.MFPR)+L20+L12 \bullet 0.743251+L15 \bullet$
0.256749

593:   $0 = WSUMJ \bullet A36/WW36 \bullet\bullet 2 \bullet (MCPR-P.MCPR)+L20+L11 \bullet 0.98091+L13 \bullet$
$0.018496+L18 \bullet 0.000603$

594:   $0 = WSUMJ \bullet A37/WW37 \bullet\bullet 2 \bullet (MGPR-P.MGPR)+L20+L15$

595:   $0 = WSUMJ \bullet A38/WW38 \bullet\bullet 2 \bullet (IM-P.IM)-L20-L06 \bullet 0.95-L16 \bullet 0.039-L17 \bullet$
0.011

596:   $0 = WSUMJ \bullet A39/WW39 \bullet\bullet 2 \bullet (IC-P.IC)-L20-L14$

597:     0 = WSUMJ*A40/WW40**2*(IPIO-P.IRIO)-L20-L06*0.483-L14*0.494-
        L16*0.019-L17*0.005

598:     0 = WSUMI*A01/W01**2*(XIOME-P.XIOME)+L01+L20-(L20+L01)*A0101-
        (L20+L02)*A0201-(L20+L03)*A0301-(L20+L04)*A0401-(L20+L05)*
        A0501-(L20+L06)*A0601-(L20+L07)*A0701-(L20+L08)*A0801-(L20+
        L09)*A0901-(L20+L10)*A1001-(L20+L11)*A1101-(L20+L12)*A1201-(
        L20+L13)*A1301-(L20+L14)*A1401-(L20+L15)*A1501-(L20+L16)*
        A1601-(L20+L17)*A1701-(L20+L18)*A1801-(L20+L01)*CF201

599:     0 = WSUMI*A02/W02**2*(XIOCP-P.XIOCP)+L02+L20-(L20+L01)*A0102-
        (L20+L02)*A0202-(L20+L03)*A0302-(L20+L04)*A0402-(L20+L05)*
        A0502-(L20+L06)*A0602-(L20+L07)*A0702-(L20+L08)*A0802-(L20+
        L09)*A0902-(L20+L10)*A1002-(L20+L11)*A1102-(L20+L12)*A1202-(
        L20+L13)*A1302-(L20+L14)*A1402-(L20+L15)*A1502-(L20+L16)*
        A1602-(L20+L17)*A1702-(L20+L18)*A1802-(L20+L02)*(CF205+CF206)

600:     0 = WSUMI*A03/W03**2*(XIODI-P.XIODI)+L03+L20-(L20+L01)*A0103-
        (L20+L02)*A0203-(L20+L03)*A0303-(L20+L04)*A0403-(L20+L05)*
        A0503-(L20+L06)*A0603-(L20+L07)*A0703-(L20+L08)*A0803-(L20+
        L09)*A0903-(L20+L10)*A1003-(L20+L11)*A1103-(L20+L12)*A1203-(
        L20+L13)*A1303-(L20+L14)*A1403-(L20+L15)*A1503-(L20+L16)*
        A1603-(L20+L17)*A1703-(L20+L18)*A1803-(L20+L03)*(CF210+CF211)

TROLL COMMAND: .PRTMOD EQ 601 TO BOTTOM:

MODEL: CURRENT

601:     0 = WSUMI*A04/W04**2*(XIOGA-P.XIOGA)+L04+L20-(L20+L01)*A0104-
        (L20+L02)*A0204-(L20+L03)*A0304-(L20+L04)*A0404-(L20+L05)*
        A0504-(L20+L06)*A0604-(L20+L07)*A0704-(L20+L08)*A0904-(L20+
        L09)*A0904-(L20+L10)*A1004-(L20+L11)*A1104-(L20+L12)*A1204-(
        L20+L13)*A1304-(L20+L14)*A1404-(L20+L15)*A1504-(L20+L16)*
        A1604-(L20+L17)*A1704-(L20+L18)*A1804-(L20+L04)*CF214

602:     0 = WSUMI*A06/W06**2*(XIOMB-P.XIOMB)+L06+L20-(L20+L01)*A0106-
        (L20+L02)*A0206-(L20+L03)*A0306-(L20+L04)*A0406-(L20+L05)*
        A0506-(L20+L06)*A0606-(L20+L07)*A0706-(L20+L08)*A0806-(L20+
        L09)*A0906-(L20+L10)*A1006-(L20+L11)*A1106-(L20+L12)*A1206-(
        L20+L13)*A1306-(L20+L14)*A1406-(L20+L15)*A1506-(L20+L16)*
        A1606-(L20+L17)*A1706-(L20+L18)*A1806-(L20+L06)*CH2

603:     0 = WSUMI*A07/W07**2*(XIOCH-P.XIOCH)+L07+L20-(L20+L01)*A0107-
        (L20+L02)*A0207-(L20+L03)*A0307-(L20+L04)*A0407-(L20+L05)*
        A0507-(L20+L06)*A0607-(L20+L07)*A0707-(L20+L08)*A0807-(L20+
        L09)*A0907-(L20+L10)*A1007-(L20+L11)*A1107-(L20+L12)*A1207-(
        L20+L13)*A1307-(L20+L14)*A1407-(L20+L15)*A1507-(L20+L16)*
        A1607-(L20+L17)*A1707-(L20+L18)*A1807-(L20+L07)*CF225

604: 0 = WSUMI+A08/W08++2+(XIOFP-P.XIOFP)+L08+L20-(L20+L01)+A0108-
(L20+L02)+A0208-(L20+L03)+A0308-(L20+L04)+A0408-(L20+L05)+
A0508-(L20+L06)+A0608-(L20+L07)+A0708-(L20+L08)+A0808-(L20+
L09)+A0908-(L20+L10)+A1008-(L20+L11)+A1108-(L20+L12)+A1208-(
L20+L13)+A1308-(L20+L14)+A1408-(L20+L15)+A1508-(L20+L16)+
A1608-(L20+L17)+A1708-(L20+L18)+A1808-(L20+L08)+CF228

605: 0 = WSUMI+A09/W09++2+(XIOPA-P.XIOPA)+L09+L20-(L20+L01)+A0109-
(L20+L02)+A0209-(L20+L03)+A0309-(L20+L04)+A0409-(L20+L05)+
A0509-(L20+L06)+A0609-(L20+L07)+A0709-(L20+L08)+A0809-(L20+
L09)+A0909-(L20+L10)+A1009-(L20+L11)+A1109-(L20+L12)+A1209-(
L20+L13)+A1309-(L20+L14)+A1409-(L20+L15)+A1509-(L20+L16)+
A1609-(L20+L17)+A1709-(L20+L18)+A1809-(L20+L09)+(CF231+CF232)

606: 0 = WSUMI+A10/W10++2+(XIOCM-P.XIOCM)+L10+L20-(L20+L01)+A0110-
(L20+L02)+A0210-(L20+L03)+A0310-(L20+L04)+A0410-(L20+L05)+
A0510-(L20+L06)+A0610-(L20+L07)+A0710-(L20+L08)+A0810-(L20+
L09)+A0910-(L20+L10)+A1010-(L20+L11)+A1110-(L20+L12)+A1210-(
L20+L13)+A1310-(L20+L14)+A1410-(L20+L15)+A1510-(L20+L16)+
A1610-(L20+L17)+A1710-(L20+L18)+A1810-(L20+L10)+(CF235+CR3)

607: 0 = WSUMI+A11/W11++2+(XIOSG-P.XIOSG)+L11+L20-(L20+L01)+A0111-
(L20+L02)+A0211-(L20+L03)+A0311-(L20+L04)+A0411-(L20+L05)+
A0511-(L20+L06)+A0611-(L20+L07)+A0711-(L20+L08)+A0811-(L20+
L09)+A0911-(L20+L10)+A1011-(L20+L11)+A1111-(L20+L12)+A1211-(
L20+L13)+A1311-(L20+L14)+A1411-(L20+L15)+A1511-(L20+L16)+
A1611-(L20+L17)+A1711-(L20+L18)+A1811-(L20+L11)+(CF239+CF240)

608: 0 = WSUMI+A12/W12++2+(XIOPF-P.XIOPF)+L12+L20-(L20+L01)+A0112-
(L20+L02)+A0212-(L20+L03)+A0312-(L20+L04)+A0412-(L20+L05)+
A0512-(L20+L06)+A0612-(L20+L07)+A0712-(L20+L08)+A0812-(L20+
L09)+A0912-(L20+L10)+A1012-(L20+L11)+A1112-(L20+L12)+A1212-(
L20+L13)+A1312-(L20+L14)+A1412-(L20+L15)+A1512-(L20+L16)+
A1612-(L20+L17)+A1712-(L20+L18)+A1812-(L20+L12)+(CF244+CF245)

609: 0 = WSUMI+A13/W13++2+(XIONC-P.XIONC)+L13+L20-(L20+L01)+A0113-
(L20+L02)+A0213-(L20+L03)+A0313-(L20+L04)+A0413-(L20+L05)+
A0513-(L20+L06)+A0613-(L20+L07)+A0713-(L20+L08)+A0813-(L20+
L09)+A0913-(L20+L10)+A1013-(L20+L11)+A1113-(L20+L12)+A1213-(
L20+L13)+A1313-(L20+L14)+A1413-(L20+L15)+A1513-(L20+L16)+
A1613-(L20+L17)+A1713-(L20+L18)+A1813-(L20+L13)+CF301

610: 0 = WSUMI+A14/W14++2+(XIOCN-P.XIOCN)+L14+L20-(L20+L01)+A0114-
(L20+L02)+A0214-(L20+L03)+A0314-(L20+L04)+A0414-(L20+L05)+
A0514-(L20+L06)+A0614-(L20+L07)+A0714-(L20+L08)+A0814-(L20+
L09)+A0914-(L20+L10)+A1014-(L20+L11)+A1114-(L20+L12)+A1214-(
L20+L13)+A1314-(L20+L14)+A1414-(L20+L15)+A1514-(L20+L16)+
A1614-(L20+L17)+A1714-(L20+L18)+A1814-(L20+L14)+(CCR2+(CD4+
CD5+(QSH68-QSH73)))

611: $0 = \text{WSUMI} \cdot A15 / W15 \cdot\cdot 2 \cdot (\text{XIOAG} - \text{P.XIOAG}) + L15 + L20 - (L20 + L01) \cdot A0115 - (L20 + L02) \cdot A0215 - (L20 + L03) \cdot A0315 - (L20 + L04) \cdot A0415 - (L20 + L05) \cdot A0515 - (L20 + L06) \cdot A0615 - (L20 + L07) \cdot A0715 - (L20 + L08) \cdot A0815 - (L20 + L09) \cdot A0915 - (L20 + L10) \cdot A1015 - (L20 + L11) \cdot A1115 - (L20 + L12) \cdot A1215 - (L20 + L13) \cdot A1315 - (L20 + L14) \cdot A1415 - (L20 + L15) \cdot A1515 - (L20 + L16) \cdot A1615 - (L20 + L17) \cdot A1715 - (L20 + L18) \cdot A1815 - (L20 + L15) \cdot CC2$

612: $\text{XIOTC} = F16 + \text{INV}16 + A1601 \cdot \text{XIOME} + A1602 \cdot \text{XIOCP} + A1603 \cdot \text{XIOOI} + A1604 \cdot \text{XIOGA} + A1605 \cdot \text{XIOEP} + A1606 \cdot \text{XIOMB} + A1607 \cdot \text{XIOCH} + A1608 \cdot \text{XIOFP} + A1609 \cdot \text{XIOPA} + A1610 \cdot \text{XIOCM} + A1611 \cdot \text{XIOSG} + A1612 \cdot \text{XIOPF} + A1613 \cdot \text{XIONC} + A1614 \cdot \text{XIOCN} + A1615 \cdot \text{XIOAG} + A1616 \cdot \text{XIOTC} + A1617 \cdot \text{XIOOT} + A1618 \cdot \text{XIOOB}$

613: $\text{XIOOT} = F17 + \text{INV}17 + A1701 \cdot \text{XIOME} + A1702 \cdot \text{XIOCP} + A1703 \cdot \text{XIOOI} + A1704 \cdot \text{XIOGA} + A1705 \cdot \text{XIOEP} + A1706 \cdot \text{XIOMB} + A1707 \cdot \text{XIOCH} + A1708 \cdot \text{XIOFP} + A1709 \cdot \text{XIOPA} + A1710 \cdot \text{XIOCM} + A1711 \cdot \text{XIOSG} + A1712 \cdot \text{XIOPF} + A1713 \cdot \text{XIONC} + A1714 \cdot \text{XIOCN} + A1715 \cdot \text{XIOAG} + A1716 \cdot \text{XIOTC} + A1717 \cdot \text{XIOOT} + A1718 \cdot \text{XIOOB}$

614: $0 = \text{WSUMI} \cdot A18 / W18 \cdot\cdot 2 \cdot (\text{XIOOB} - \text{P.XIOOB}) + L18 + L20 - (L20 + L01) \cdot A0118 - (L20 + L02) \cdot A0218 - (L20 + L03) \cdot A0318 - (L20 + L04) \cdot A0418 - (L20 + L05) \cdot A0518 - (L20 + L06) \cdot A0618 - (L20 + L07) \cdot A0718 - (L20 + L08) \cdot A0818 - (L20 + L09) \cdot A0918 - (L20 + L10) \cdot A1018 - (L20 + L11) \cdot A1118 - (L20 + L12) \cdot A1218 - (L20 + L13) \cdot A1318 - (L20 + L14) \cdot A1418 - (L20 + L15) \cdot A1518 - (L20 + L16) \cdot A1618 - (L20 + L17) \cdot A1718 - (L20 + L18) \cdot A1818 - (L20 + L18) \cdot (\text{CF268} + \text{CF269})$

615: $\text{CFPU} == \text{CFPR} + \text{TT70IOC} \cdot \text{CFPR} / \text{CIO}$

616: $\text{CNPU} == \text{CNPR} + \text{TT70IOC} \cdot \text{CNPR} / \text{CIO}$

617: $\text{CDPU} == \text{CDPR} + \text{TT70IOC} \cdot \text{CDPR} / \text{CIO}$

618: $\text{CSPU} == \text{CSPR} + \text{TT70IOC} \cdot \text{CSPR} / \text{CIO}$

619: $\text{CRF70} = \text{CFPU} / 1.01433$

620: $\text{CRND70} = \text{CNPU} / 0.91868$

621: $\text{CRD70} = \text{CDPU} / 0.95651$

622: $\text{CRS70G} == \text{CSPU} / 0.14305$

623: $\text{CRS70} = \text{CRS70G} + \text{NMG} \cdot 1282.83 \cdot 1.000000E-06$

624: $\text{CR70} = \text{CRND70} + \text{CRF70} + \text{CRD70} + \text{CRS70}$

625: $\text{BAO} = \text{P.BAO} / \text{P.GSBA} \cdot \text{GSBA}$

626: $\text{BFD} = 1000 / 99.27 \cdot ((\text{GSBA} + 0.276 \cdot \text{TT70IOG}) \cdot 9619 / 3430 \cdot 3287 / 4027 - 17 \cdot \text{BAO} / 1000)$

627:       EPM == ERPR♦PREX9♦PTX9/97♦4736/7000

628:       EMM == EMPR♦PREX9♦PTX9/97♦1351.1/1856

629:       EFM == EFPR♦PREX9♦PTX9/97♦815.6/742

630:       ECM == ECPR♦PREX9♦PTX9/97♦933.4/758

631:       ETW = (ERM+EMM+EFM+ECM)♦1000

632:       ETW70 = 1.5♦(100♦ETW)/(PREX9♦PTX9)

633:       MRPU == MRPR♦2558/2591/(1-1/P.MPU♦TT70IDM/0.9456)

634:       MMPU == MMPR♦1612/1793/(1-1/P.MPU♦TT70IDM/0.9456)

635:       MFPU == MFPR♦1714.5/1741/(1-1/P.MPU♦TT70IDM/0.9456)

636:       MCPU == MCPR♦4786/4808/(1-1/P.MPU♦TT70IDM/0.9456)

637:       MRM == MRPU♦PREX9♦PTM9/94♦2043/2672

638:       MMM == MMPU♦PREX9♦PTM9/94♦2731.5/1683.7

639:       MFM == MFPU♦PREX9♦PTM9/94♦1124.9/1790.8

640:       MCM == MCPU♦PREX9♦PTM9/94♦1209.3/4998.7

641:       MGPDW = MGPR/103♦PWUS♦1000♦679/798

642:       MTW = (MRM+MMM+MFM+MCM)♦1000+MGPDW

643:       MTW70 = 2♦100♦MTW/(PREX9♦PTM9)

644:       ITOTAL = (IC+IM)/0.96

645:       ICR = IRID♦1000/186.11

646:       GEUSUM = ITOTAL+C874♦ICR+FRES-UNFINC-OTHERCON+C963♦BAD+C964♦
       BRD+C965/C966♦NMD9+100♦BDN9/PIWH70

647:       IA = IRA9♦ITOTAL

648:       IAM = P.IAM/P.IA♦IA

649:       IAC = P.IAC/P.IA♦IA

650:       INA = ITOTAL-IA

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